States
ment of
lture

and
ealth
on

Medfly Cooperative Eradication Program

Draft Environmental Impact Statement—1993

United States Department of Agriculture

Animal and Plant Health Inspection Service

In cooperation with:

United States Department of Agriculture, Agricultural Research Service

United States Department of Agriculture, Forest Service

United States Environmental Protection Agency

Alabama Department of Agriculture and Industries

Arizona Department of Agriculture

California Department of Food and Agriculture

Florida Department of Agriculture and Consumer Services

Georgia Department of Agriculture

Louisiana Department of Agriculture and Forestry

Mississippi Department of Agriculture

South Carolina, Department of Plant Industry

Texas Department of Agriculture

Medfly Cooperative Eradication Program

Draft Environmental Impact Statement—April 1993

Agency Contact:
Harold T. Smith
Branch Chief, Environmental Analysis and Documentation
Biotechnology, Biologics, and Environmental Protection
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
6505 Belcrest Road, Room 543
Hyattsville, MD 20782

Abstract:
The U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), in cooperation with other Federal and state organizations, is proposing a program to eradicate the Mediterranean fruit fly from areas of the United States that it may infest in the future. APHIS and its cooperators analyzed a range of alternatives, including: no action, Medfly suppression (including chemicals), Medfly suppression (no chemicals), Medfly eradication (including chemicals), and Medfly eradication (no chemicals). Each alternative was determined to have potential for adverse environmental consequences. Medfly eradication (including chemicals) was chosen as the preferred alternative because it was determined to have the best chance of meeting the eradication objective while resulting in relatively short-term use of pesticides. Program standard operational procedures and mitigative measures will serve to negate or reduce the potential environmental consequences of this program.

Comments must be received by May 24, 1993.

Trade and company names are used in this publication solely to provide specific information. Mention of a trade or company name does not constitute a warranty or an endorsement by the U.S. Department of Agriculture to the exclusion of other products or organizations not mentioned.

Registration of pesticides are under constant review by the U.S. Environmental Protection Agency (EPA). Only pesticides that bear the EPA registration number and carry the appropriate directions should be used.

Table of Contents

Tables

Tables, continued

Figures

Executive Summary

The Mediterranean fruit fly or Medfly, *Ceratitis capitata* (Wiedemann), is a major pest of agriculture throughout the world and represents a serious threat to U.S. agriculture. The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), in cooperation with other Federal and state organizations, is proposing a program to eradicate the Medfly from areas of the conterminous United States that it may infest in the future. APHIS has prepared this environmental impact statement (EIS) of the proposed Medfly Cooperative Eradication Program in accordance with the National Environmental Policy Act of 1969 (NEPA) and the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.

APHIS and its cooperators analyzed a broad range of alternatives and associated control methods in this EIS. The alternatives are broad in scope and reflect the major choices that must be made for the program: no action, Medfly suppression (including chemicals), Medfly suppression (no chemicals), Medfly eradication (including chemicals)—the preferred alternative, and Medfly eradication (no chemicals). The control methods analyzed in the EIS are the specific techniques used in insect control or eradication; they are limited in scope and reflect the means by which the program objective may be met. Control methods analyzed include chemical control, nonchemical control, and combined control.

Each alternative (including no action) has potential for adverse environmental consequences. The no action alternative has the highest potential for adverse environmental consequences because it would ultimately result in an expanded Medfly infestation that would be responded to with increasing and uncoordinated use of pesticides. The consequences associated with each alternative are related to the alternative's use of control methods, or as in the case of no action, even to nonprogram use of controls. The chemical control methods (program or nonprogram uses) were determined to have greater potential for adverse environmental consequences than the nonchemical control methods which have little, if any, potential for adverse environmental consequences. Of the program chemicals, the soil drench chemicals have the greatest potential for adverse human health effects, especially for pesticide applicators, but would be used only in limited areas. Aerially applied malathion bait has the greatest potential for adverse effects on populations of nontarget species, and may adversely affect sensitive segments of the human population as well. Ground application of malathion bait precisely targets host vegetation and therefore reduces potential adverse effects to many nonhuman nontarget species, but may adversely affect program pest control applicators.

The preferred alternative, Medfly eradication (including chemicals), was determined to have the best chance of meeting the eradication objective and would result in relatively short-term use of pesticides. Selection of the Medfly suppression (including chemicals) alternative would result in a program of indefinite duration that would lead to constantly increasing use of pesticides,

concentrating on commercial agricultural lands. The no action, Medfly suppression (no chemicals), and Medfly eradication (no chemicals) alternatives also would be expected to result in increased commercial and private use of pesticides as the Medfly expands its range in the conterminous United States. Additionally, the Medfly eradication (no chemicals) alternative is not expected to succeed, given the current state of nonchemical Medfly eradication technology.

The geographical scope of the program was predicted based on factors relating to host range, climate, potential avenues of introduction, and past introductions. Areas of the following States may be subject to program control operations: Alabama, Arizona, California, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas. Because parts of the potential program area share common characteristics (especially with regard to physical character and biological resources), the EIS used six ecological regions (ecoregions) in its approach. The ecoregions, adapted from several classification systems in use, included: California Central Valley and Coastal, Southwestern Basin and Range, Lower Rio Grande Valley, Southeastern and Gulf Coastal Plain, Mississippi Delta, and Floridian. The physical environment, biological resources, human population, cultural, and visual resources were all discussed in relation to the six ecoregions.

Potential environmental consequences of the Medfly Cooperative Eradication Program would be the result of or be related to the program's use of control methods (especially chemical control methods). Classical risk assessment methodology and computer modeling were used for qualitative and quantitative determination of environmental risk. Human health and nontarget species risk assessments were completed separately and are incorporated by reference in the EIS. Although the EIS focuses on the chemical control methods, it analyzes effects of both chemical and nonchemical control methods on the physical environment, human health and safety, socioeconomics, cultural and visual resources, and biological resources. The effects of the control methods are analyzed individually; cumulative impacts of combined uses of program controls or program controls plus nonprogram controls are also analyzed.

Standard operational procedures and program mitigative measures serve to negate or reduce environmental impact of the program. Standard operational procedures are routine procedures required of the program and its employees to safeguard human health and the natural environment; they are generic in nature and may be substantially the same as those developed for other APHIS cooperative programs. Program mitigative measures are measures developed for the purpose of avoiding, reducing, or rectifying environmental impact; they were developed specifically for this program, taking into account unique characteristics of the program, and may differ from those used for other programs. Standard operational procedures include general procedures and specific procedures for chemical applications, aerial operations, and ground operations. Recommended mitigative measures include measures for the protection of human health (including workers and the public), nontarget species (including

honey bees, endangered and threatened species, wildlife, livestock, and pets), and the physical environment.

APHIS and its cooperators will monitor treatment areas to determine the environmental consequences and the efficacy of the Medfly Cooperative Eradication Program. An environmental monitoring plan serves as a basis for environmental monitoring anywhere within the potential program area. The plan may be modified based on site-specific aspects of the actual program area when a program is implemented. Procedures for efficacy monitoring and procedures for handling accidental spills are outlined in guidelines, policies, and manuals of APHIS and its cooperators.

In the planning and implementation of program actions, APHIS and its cooperators comply with a variety of environmental laws and policies. This EIS has been prepared specifically to meet the needs of the National Environmental Policy Act of 1969. The Endangered Species Act of 1973 also provides for biological assessment of potentially affected endangered and threatened species in a process that is separate from, yet parallel in many respects to, that of this EIS. APHIS will rely on its program cooperators to identify applicable state environmental regulations, take the lead for their procedures, and ensure full compliance with state laws.

APHIS concluded that each alternative has potential for adverse environmental consequences related to program use of control methods or, in some cases, resultant nonprogram use of control methods. Nonchemical control methods were determined to offer little, if any, potential for adverse environmental consequences. Chemical control methods are expected to result in varying degrees of risk to the human environment, some short-term cumulative effects, and some unavoidable environmental effects. In general, the program's standard operational procedures and recommended mitigative measures will serve to negate or reduce environmental risks.

I. Introduction

A. The Proposed Action

The Mediterranean fruit fly or Medfly, *Ceratitis capitata* (Wiedemann), is a major pest of agriculture throughout many parts of the world. Because of its wide host range (over 250 species of fruits and vegetables), the Medfly represents a serious threat to U.S. agriculture. The Medfly has been introduced intermittently to the U.S. mainland since its original introduction in 1929; however, eradication programs have been implemented to prevent it from becoming a permanent pest on the U.S. mainland. The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) has cooperated with various state departments of agriculture in many of those previous eradication programs.

APHIS, in cooperation with other government agencies (refer to table I-1), is proposing a program to eradicate Medfly from areas of the conterminous United States where it may be introduced in the future. Such a program involves actions that are recurrent, may be considered broad in scope, have common features, have potential environmental impacts, and can be reasonably planned for in advance. Therefore, APHIS, as lead agency, decided to cooperatively develop a programmatic environmental impact statement (EIS) for the Medfly Cooperative Eradication Program. APHIS and its cooperators analyzed eradication, suppression, and no action alternatives for Medfly control; they chose Medfly eradication (including chemicals) as the preferred alternative for this program. Control methods that are compatible with and may be used within this alternative include chemical control, sterile insect technique, physical control, cultural control, regulatory control, and integrated pest management.

Table I-1. Federal and State Organizations Cooperating in Development of the Medfly Cooperative Eradication Program EIS

Federal

- USDA, Animal and Plant Health Inspection Service (Lead Agency)
- USDA, Agricultural Research Service
- USDA, Forest Service
- U.S. Environmental Protection Agency

State

- Alabama Department of Agriculture and Industries
- Arizona Department of Agriculture
- California Department of Food and Agriculture
- Florida Department of Agriculture and Consumer Services
- Georgia Department of Agriculture
- Louisiana Department of Agriculture and Forestry
- Mississippi Department of Agriculture
- South Carolina Department of Plant Industry
- Texas Department of Agriculture

B. The Medfly and Its Distribution

The Medfly belongs to the fruit fly family Tephritidae, a group of about 4,000 species distributed throughout the tropical, subtropical, and temperate areas of the world. The larvae of many tephritids feed within fruit, and some (like the Medfly) are major pests of agriculture. Adult Medflies feed on protein exudations (sap or honeydew) from plants. The female causes superficial scars on host fruits and vegetables when she pierces the skin of the host to lay eggs. However, larvae feeding upon the fleshy interior of the host fruit can result in extensive damage, including insect-contaminated fruit, rotted fruit, and premature drop of fruit.

Figure I-1. The adult Medfly is slightly smaller than the housefly and has distinctive patterns on its wings. (Photo credit USDA, APHIS)

Adult mated female Medflies deposit their eggs within fruit by piercing the skin of the fruit with a needle-like ovipositor (egg-laying appendage). The tiny eggs hatch into larvae within 1 to 2 days. The larvae (slender, cream-colored maggots) feed on the pulp of the fruit and destroy the fruit in the process. The larvae complete their development in 7 to 11 days and, when mature, leave the fruit. By this time, the fruit may have dropped to the ground. The larvae leave the fruit and enter the soil. In the soil, the larvae change into pupae. Within 8 to 14 days, the pupae change into adult Medflies which then emerge from the soil. After the adults become sexually mature (in 4 to 5 days or more depending upon temperature and diet) they mate, the females lay eggs, and the life cycle begins again. Adults usually live 30 to 60 days, though eggs may not be produced throughout this period.

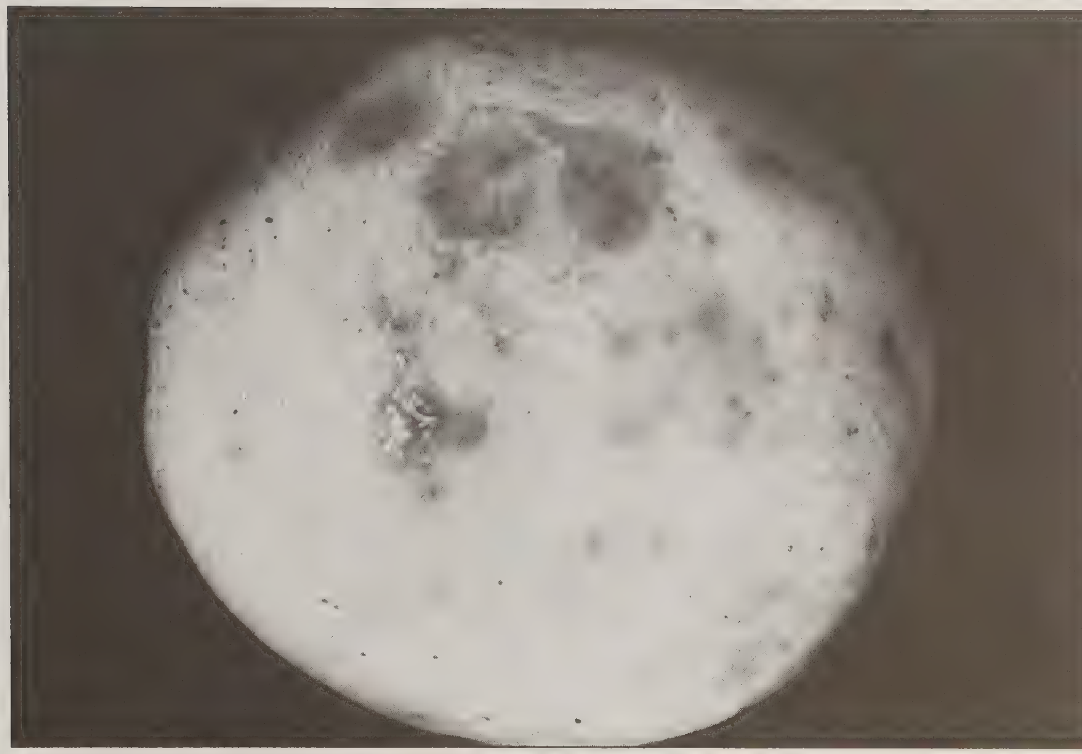


Figure I-2. Oviposition scars, as on this grapefruit, are caused when the females pierce the skin of the fruit to lay their eggs. (Photo credit USDA, APHIS)

Figure I-3. The larva of the Medfly is a slender cream-colored maggot. (Photo credit USDA, APHIS)

Figure I-4. Medflies develop into pupae, generally in the soil underneath infested hosts. (Photo credit USDA, APHIS)

The Medfly is distributed widely in Africa and the Middle East. It is considered the worst fruit fly pest in the Mediterranean region (including Egypt, Libya, Tunisia, Algeria, and Morocco) because of its abundance and its wide host range. The Medfly is found in Portugal, Spain, the Spanish Canary Islands, Italy, and France. It has occurred throughout western and central European countries, but no outbreaks are known to have occurred in the United Kingdom, Scandinavia, Rumania, or Bulgaria. It was introduced to Australia from Europe around 1897 and is now found on Australia's western coast.

The Medfly currently infests areas of Hawaii, and is known to have occurred there since 1910; Hawaii is considered a potential source of infestation for the U.S. mainland. The Medfly was introduced to the New World in Brazil between 1901 and 1905. First reported in Central America in Costa Rica in 1955, it has moved north gradually since then. The Medfly first appeared in Mexico in 1977, but was eradicated, with substantial effort, after 6 years. The Medfly is not currently established in Mexico.

Humans have had a dominant role in the 20th century distribution of Medfly by: (1) expanding and facilitating world travel, (2) increasing trade in agricultural produce (including Medfly host produce), (3) cultivating fruit trees in association with human habitats, (4) immigrating and subsequently maintaining certain cultural ties, customs, and foods, (5) smuggling prohibited fruits and vegetables, and (6) increasing the range of certain weeds which are hosts to Medfly. The Medfly's wide host range is also an important factor in its distribution. Medfly host material is prevalent in many tropical and temperate areas of the world, and those areas are at risk of Medfly establishment.

C. Scope and Focus

The geographical scope of the Medfly Cooperative Eradication Program and this EIS is based on factors relating to climate, host availability, potential avenues of introduction, and past introductions. It was determined that Medfly has the potential to infest areas of Alabama, Arizona, California, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas. Refer to table I-2 for a list of program States and counties and parishes that have the highest risk of Medfly introduction and infestation. These potential program areas are analyzed within the EIS.

Table I-2. Counties and Parishes of the Conterminous United States Identified as Potential Medfly Cooperative Eradication Program Areas[1]

State	County or Parish
Alabama	Baldwin, Mobile
Arizona	Cochise, Maricopa, Pima, Pinal, Santa Cruz, Yuma
California	Alameda, Contra Costa, Fresno, Imperial, Kern, Kings, Los Angeles, Orange, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Tulare, Ventura
Florida	Brevard, Broward, Dade, Hillsborough, Indian River, Lee, Monroe, Orange, Palm Beach, Pinellas, St. Lucie, Seminole
Georgia	Chatham
Louisiana	Jefferson, Lafourche, Orleans, Plaquemines, St. Bernard, St. Charles
Mississippi	Harrison
South Carolina	Beaufort, Charleston
Texas	Cameron, Harris, Hidalgo, Starr, Willacy

[1]Mutually agreed upon by program cooperators based on factors relating to climate, host availability, potential avenues of introduction, and past introductions.

The organizational scope of the EIS includes the analysis of all reasonable alternatives for the program action and a full range of control methods. Refer to chapter III, Alternatives, for a discussion of potential alternatives, control methods, and associated impacts. Issues identified at the outset by APHIS for comprehensive consideration within the EIS included: potential impacts of the alternatives on human health and safety; potential impacts of the alternatives on the physical environment, including soil, water quality, and air quality; and potential impacts of the alternatives on other aspects of the human environment, such as nontarget species, wilderness areas, domestic animals, recreation, the cultural environment, public attitudes, and energy.

In the formal scoping for the EIS (from June 22, 1990, to November 9, 1990), APHIS solicited comments from the public (individuals, environmental groups, industry, and government agencies). During scoping, public meetings were held in: Mesa, Arizona, on September 11, 1990; Brownsville, Texas, on

September 13, 1990; Los Angeles, California, on September 18, 1990; San Jose, California, on September 20, 1990; Miami, Florida, on September 25, 1990; and Washington, DC, on October 9, 1990. Oral and written comments received during the scoping period were considered fully by APHIS in the planning of the EIS. Issues and concerns identified by the public included: potential impacts to human health (chronic and acute toxicology, and chemical hypersensitivity), potential effects of program chemical control methods, potential impacts on nontarget species, and potential impacts to the physical environment.

The comments received from the public helped APHIS to determine the principal focus of the EIS. The EIS focuses on the potential environmental consequences of chemical controls, especially the use of malathion with protein bait, and their alternatives. From the history of past programs and the scoping process, APHIS and its cooperators acknowledge the public's concern about the potential impacts of program chemical controls on human health, biological resources, and the physical environment.

D. Programmatic Analysis and Site-specific Review

This EIS is a broad, programmatic analysis of the potential environmental consequences of actions to eradicate the Medfly from areas of the conterminous United States. It focuses on the program's alternatives and potential environmental issues, and is not intended to serve as an encyclopedic compendium about the program. Although the EIS is meant to provide a broad view of the program, it also conveys the specific procedures which APHIS and its cooperators will follow prior to implementation of a program to ensure that site-specific characteristics of the program area are considered.

Prior to implementing a program, APHIS and its cooperators will consider such site-specific characteristics as: (1) unique and sensitive aspects of the proposed program area; (2) applicable environmental documentation, including the programmatic EIS; and (3) applicable new developments in environmental science or control technologies. To the extent possible, when separate Federal and state site-specific environmental reviews are prepared, they will be coordinated.

Site-specific review of the program area will consider such things as: unique land usage patterns (including agricultural cropping), unique or sensitive areas, water bodies and their drainage, endangered and threatened species, human population density, cultural factors, and unique human health issues (such as homeless people, the hypersensitive, or ethnic groups that require special notification procedures) . APHIS and its cooperators will review existing environmental documentation, including the EIS, risk analyses, biological assessments, and any site-specific tiered environmental assessments to ensure that program procedures and protective measures are appropriate. Also, after the publication of the EIS, APHIS and its cooperators will consider new developments in environmental science (new findings or requirements related to potential risk to humans or other nontarget species) and in scientifically and operationally proven control technologies (new, more efficacious, and more environmentally sound controls).

The site-specific review will be appropriate, based upon the circumstances, issues, and timeframe of need for the program. Generally, the site-specific assessment prepared for a program will be adequate to analyze and disclose new and important information relative to a particular program area. In cases where major changes are apparent, a supplement to the EIS or a new EIS may be required. Specific procedures for site-specific evaluation are included within the EIS.

Figure I-5. The cardboard Jackson trap is used to detect and delimit Medfly infestations. (Photo credit USDA, APHIS)

II. Purpose and Need

The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), as lead agency in cooperation with other Federal and state organizations (refer back to table I-1 for list), is proposing a program to eradicate the Mediterranean fruit fly (or Medfly), *Ceratitis capitata* (Wiedemann), an exotic agricultural pest, from areas of the conterminous United States that it may infest in the future. This program is necessary because of the Medfly's destructive potential and the serious threat it represents to United States agriculture. Refer to table I-2 for a list of states and counties that are potential program areas.

APHIS' authority for cooperation in the program is based upon the Organic Act (7 United States Code (U.S.C.) 147a), which authorizes the Secretary of Agriculture to carry out operations to eradicate insect pests, and the Federal Plant Pest Act (7 U.S.C. 150dd), which authorizes the Secretary of Agriculture to use emergency measures to prevent dissemination of plant pests new to or not widely distributed throughout the United States.

APHIS and its cooperators have joined to evaluate all reasonable alternatives for the control of the Medfly, including eradication, suppression, and no action. This environmental impact statement (EIS) analyzes, in the broad sense, the potential environmental consequences of those alternatives and their component control methods. It examines currently available and potential future technologies and practices, and focuses on the environmental consequences of program use of chemical control methods. The EIS is not a decision document, but it will be used in conjunction with other relevant material to plan actions and make decisions. It fulfills the need to inform decisionmakers and the public of potential environmental impacts and reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment.

Figure II-1. Medfly larvae destroy fruit in the process of feeding. (Photo credit USDA, APHIS)

III. Alternatives

A. Introduction

The Animal and Plant Health Inspection Service (APHIS) and its cooperators have analyzed a range of reasonable alternatives and associated control methods in this environmental impact statement (EIS). The alternatives are broad in scope (strategic) and reflect the choice of program objective that must be made from Medfly eradication, Medfly suppression, or no action. The control methods are the specific techniques used in insect control or eradication. They are limited in scope (tactical), reflecting the means by which the program objective may be met. Refer to table III-1 for a summary listing of potential alternatives together with applicable control methods.

Table III-1. Alternatives and Applicable Control Methods

	Alternatives				
	No Action	Medfly Suppression (Including Chemicals)	Medfly Suppression (No Chemicals)	Medfly Eradication (Including Chemicals)	Medfly Eradication (No Chemicals)
Chemical Control Methods					
Malathion Bait Spray Aerial Application		✔		✔	
Malathion Bait Spray Ground Application		✔		✔	
Diazinon		✔		✔	
Chlorpyrifos		✔		✔	
Fenthion		✔		✔	
Methyl Bromide		✔		✔	
Nonchemical Control Methods					
Sterile Insect Technique		✔	✔	✔	✔
Physical Control		✔	✔	✔	✔
Cultural Control		✔	✔	✔	✔
Male Annihilation		✔	✔	✔	✔
Biological Control[1]					
Biotechnological Control[1]					
Combined Control Methods					
Regulatory Control[2]		✔	✔	✔	✔
Integrated Pest Management[2]		✔	✔	✔	✔

✔Indicates control methods available under the alternatives.
[1]Future potential, but not proven efficacious or technologically feasible now.
[2]May be structured to include chemical methods, nonchemical methods, or a combination of both.

The alternatives and control methods analyzed are reasonable, but vary with regard to their practicality or feasibility based on technical, scientific, regulatory, economic, and logistical perspectives. They may vary considerably with regard to their effectiveness, capability to attain the program objective, and immediate applicability for large-scale programs. Accordingly, suppression alternatives and control methods specific to suppression are discussed in the EIS as alternatives to the preferred alternative even though they may not meet the underlying purpose and need of the program.

B. Alternatives Evaluated

1. Alternatives' Environmental Consequences

Analysis has determined that there are potential environmental consequences for each of the alternatives, including the no action alternative. Those environmental consequences would be the result of the program use of any or a combination of control methods as component parts of the alternative selected (for the action alternatives) or would be the result of unpredictable and uncoordinated nonprogram use of control methods against the Medfly (in the case of no action). The environmental consequences of a future Medfly Cooperative Eradication Program may be predicted generally, but cannot be predicted with absolute confidence because of the uncertainties regarding the area, the extent of infestation, the future availability of control methods, and the selection of an alternative.

The potential environmental consequences of each alternative were determined subjectively by: (1) presuming that a combination of all control methods available under that particular alternative could be used, (2) considering the findings of the qualitative and quantitative risk assessments (see chapter V, Environmental Consequences), (3) summarizing the potential environmental consequences for each control method, and (4) considering the potential environmental consequences of the combination of control methods available under each alternative to summarize the potential for environmental consequences for the alternative (see table III-2, Alternatives Evaluated).

The levels of consequences used to characterize the alternatives and the control methods were as follows:

0 = None	No anticipated environmental consequences.
1 = Minimal	Minimal or minor environmental consequences; determination based on initially low intrinsic effects or on reduction of effects to minimal levels by means of programmatic standard operational procedures or existing mitigative measures.
2 = Higher	Higher potential for environmental consequences than above category; could not be reduced to minimal levels through application of programmatic standard operational procedures and/or existing mitigative measures, but potentially subject to further reduction based on site-specific characteristics or new mitigative measures.

U = Unknown Unknown potential for environmental consequences; control technology may be in an early stage of development, not enough details are known about potential environmental consequences, or more detailed information about control methods and patterns of use are required.

Table III-2. Alternatives Evaluated

Potential Consequences*
0 = None
1 = Minimal
2 = Higher
U = Unknown

	Alternatives: No Action	Medfly Suppression (Including Chemicals)	Medfly Suppression (No Chemicals)	Medfly Eradication (Including Chemicals)	Medfly Eradication (No Chemicals)
Chemical Control Methods		2		2	
Malathion Bait Spray Aerial Application		2		2	
Malathion Bait Spray Ground Application		1		1	
Diazinon		2		2	
Chlorpyrifos		2		2	
Fenthion		2		2	
Methyl Bromide		1		1	
Nonchemical Control Methods		1	1	1	1
Sterile Insect Technique		1	1	1	1
Physical Control		1	1	1	1
Cultural Control		1	1	1	1
Male Annihilation		1	1	1	1
Biological Control		U	U	U	U
Biotechnological Control		U	U	U	U
Combined Control Methods**		2	2	2	2
Regulatory Control		2	1	2	1
Integrated Pest Management		2	2***	2	2***
Summary Evaluation	2***	2	2	2	2

*Refer to text for further definition of categories, as used in this comparison.
**May include chemical and/or nonchemical methods, depending upon alternative.
***Based on resultant nonprogram use of pesticides.
(Shaded areas represent alternatives that are not applicable to control methods.)

For a programmatic perspective, the alternatives and their control methods were rated and compared, based on detailed objective and subjective analysis. A more critical comparison of the alternatives and their potential environmental consequences cannot be accomplished without knowing more about the site-specific characteristics of a potential program area. In an actual program, the potential environmental effects can be reduced considerably through

appropriate selection of control methods and employment of program standard operational procedures and mitigative measures. Refer to chapter V, Environmental Consequences, for more specific information regarding the anticipated environmental consequences of the proposed control measures.

a. No Action

The most probable outcome of the no action alternative would be that Medfly would establish a permanent foothold and continually expand its range within the conterminous United States. Medfly would eventually spread to all areas of the conterminous United States having suitable hosts and climate. This would result in widespread destruction of commercial food crops and urban garden products. Because of its threat to foreign agricultural systems, host produce from the United States could be restricted or prohibited entry into certain countries, decreasing current agricultural markets and potential export markets.

Without a coordinated effort to eradicate or control the Medfly, losses and damage to private and commercial crops would provoke individual control efforts. Those efforts would result in continually increasing use of controls by homeowners and agriculturists, with uncoordinated and less controlled use of any pesticides that are available. The potential environmental consequences could be expected to increase as the Medfly infestation expands. Under the no action alternative, the potential for environmental consequences would surpass that from a cooperative eradication program using chemicals.

The severity of environmental consequences to human health, nontarget species, and the physical environment would depend upon the characteristics of the pesticides used by homeowners and growers to control Medfly. Lacking the resources or capability to utilize certain program techniques, such as detection trapping, sterile insect technique, and regulatory controls, homeowners and growers could be expected to rely predominantly on chemical pesticides. Under these circumstances, the public also would be uninformed of the times and areas of applications, and therefore unable to take measures to avoid exposure. Public exposure to various pesticides used privately or commercially at differing application rates also poses increased risks of synergistic or cumulative effects from the interaction of the pesticides.

b. Medfly Suppression (Including Chemicals)

Under the Medfly suppression (including chemicals) alternative, potential environmental consequences will result from the use of chemical control methods, or use of chemicals in combined control methods. Under a Medfly suppression program, the Medfly probably would continue to expand its range resulting in more and broader control being required to keep it in check. As with no action, an expanded Medfly infestation would result in greater damage to commercial crops and home garden products, as well as decreased domestic markets and lost export markets.

An expanding Medfly infestation would result in continually increasing pesticide load to the environment, and the potential environmental consequences would surpass those expected from a cooperative eradication program using chemicals. However, the consequences of this alternative would be less than those associated with the no action or nonchemical control alternatives, because of the resulting widespread commercial and private use of pesticides in those other alternatives.

The environmental consequences of a Medfly suppression (including chemicals) alternatives would depend to a large degree on the objective and scope of the program. If, for example, the program targeted only commercial agricultural areas for treatments, then the exposure to the public and to nontarget wildlife might be relatively small. Such treatments would go largely unnoticed by the public, but would put a burden upon industry as additional areas needed to be treated. In addition, if the program targeted commercial agricultural areas only, the public might be expected to use any available pesticides to combat Medfly infestations in home plantings, posing additional risks to human health and to nontarget species.

c. Medfly Suppression (No Chemicals)

The Medfly suppression (no chemicals) alternative would not use chemicals for control purposes and would be expected to diminish the immediate potential for environmental consequences. However, over time, such a suppression program would result in the expansion of the Medfly's range, with resulting damage to commercial crops and home garden products.

As with no action and Medfly suppression (including chemicals), commercial and homeowner needs to reduce losses and damages to acceptable levels would prompt use of any control methods that are available. This nonprogram use of pesticides would increase as the Medfly range expands, and would result in an increasing pesticide load to the environment with accompanying potential for cumulative and synergistic effects on humans, and potential effects on nontarget species. Because of the more rapid Medfly expansion expected under this alternative, as compared to the Medfly suppression (including chemicals) alternative, this alternative's potential for adverse environmental impact from nonprogram use of pesticides is greater.

d. Medfly Eradication (Including Chemicals)—Preferred Alternative

The Medfly eradication (including chemicals) alternative would minimize potential for damage by the Medfly and would negate its ability to spread to other areas. Minimal damage would occur to commercial crops and home garden products, and current markets (domestic and export) would be preserved.

The potential environmental consequences associated with a Medfly eradication (including chemicals) alternative are related principally to the use of chemical control methods. Although this alternative uses the same chemical control methods as the Medfly suppression (including chemicals) alternative, its potential for environmental consequences would be less because it quickly

eliminates Medfly while the area of infestation (thus, the treatment area) remains small. In addition, government coordination further reduces the potential for public exposure to pesticides through public notification prior to treatment and safety procedures to be followed by program personnel. Risks of cumulative effects and synergistic effects on human health are also reduced through government control of pesticide usage. A more precise comparison of the alternatives which use chemicals is not possible because of variations within those alternatives (variations in application methods, usage patterns, and complementary control methods that may be expected to occur in response to site-specific circumstances); such flexibility is an integral part of a control method such as integrated pest management, where component controls are selected based on environmental, operational, and economic factors.

The potential environmental consequences of this alternative on nontarget wildlife species would result principally from the program use of chemical pesticides, including malathion bait spray applications and the soil drenches; only minimal effects on nontarget species would be expected as a consequence of nonchemical methods such as cultural and physical control.

e. Medfly Eradication (No Chemicals)

The Medfly eradication (no chemicals) alternative, given the current state of nonchemical eradication technologies, would result in failure. That failure could require a change in course to a program using chemicals or to a no action alternative. At least one previous attempt to eradicate Medfly without chemicals failed (Santa Clara County, California, in 1980), resulting in the need for an eradication program using chemicals that had to be implemented over a much wider area than would have been necessary had chemical controls been employed initially.

The expected failure to eradicate a Medfly infestation using this alternative would result in potential environmental consequences to human health and safety from the resulting uncoordinated nonprogram use of pesticides. Also, failure of the alternative would result in an expanded infestation that, if chemical pesticides were used to eradicate, would have even greater potential for environmental consequences than if the pesticides had been used earlier in a more confined area. Risks to nonhuman nontarget organisms would similarly increase with this alternative.

2. Control Methods' Environmental Consequences

Control methods (chemical and nonchemical) proposed or available for use within this program vary considerably with respect to their potential environmental consequences. The risk assessments incorporated by reference in this EIS (see chapter V, Environmental Consequences) used qualitative and quantitative methods in the determination of risk. From the risk assessments and the subjective evaluations done for this EIS, a broad categorization of the potential environmental effects of the control methods was developed (refer to table III-3).

Table III-3.Control Methods Evaluated

Potential Consequences*
0 = None
1 = Minimal
2 = Higher
U = Unknown

	Physical Environment	Human Health and Safety	Biological Resources	Socioeconomics	Cultural and Visual Resources	Cumulative Effects	Unavoidable Environmental Effects
Chemical Control Methods	1	2	2		1	2	2
Malathion Bait Spray Aerial Application	1	1	2				
Malathion Bait Spray Ground Application	1	1	1				
Diazinon	1	1	2				
Chlorpyrifos	1	2	2				
Fenthion	1	2	2				
Methyl Bromide	U	1	1				
Nonchemical Control Methods	1	1	1		1	1	1
Sterile Insect Technique	1	1	1				
Physical Control	1	1	1				
Cultural Control	1	0	1				
Male Annihilation	1	0	1				
Biological Control	U	U	U				
Biotechnological Control	U	U	U				
Combined Control Methods**	1	2	2		1	2	2
Regulatory Control	1	2	2				
Integrated Pest Management	1	2	2				

*Refer to text for further definition of categories, as used in this comparison
**May include chemical and/or nonchemical methods, depending upon alternative.
(Method-by-method assessment not done where indicated by shading.)

The control methods were evaluated individually with respect to potential effects on the physical environment, human health and safety, and biological resources. They were evaluated as groups with respect to potential effects on socioeconomics, cultural and visual resources, cumulative effects, and unavoidable environmental effects. The control method evaluation used the same terminology described previously for the alternatives: none, minimal, higher, or unknown.

a. Chemical Control Methods

The chemical control methods were generally considered to have minimal environmental consequences for the physical environment (principally because of their rapid degradation or dissipation characteristics) and cultural and visual resources. Potential cumulative environmental effects and unavoidable

environmental effects were determined to fall into the higher category of consequences.

The chemical control methods were considered to present higher consequences than the nonchemical methods for human health and safety; those findings normally were based on risks to certain groups of people rather than the general public (for which risks were generally minimal). Subsegments of the population which were at higher risk included pesticide workers, hypersensitive people, and the very young. Subjectively, the soil drenches were determined to have the greatest potential for adverse environmental effects, followed in order by aerial and then ground malathion bait applications and methyl bromide fumigation.

Several of the chemical control methods were also considered to have higher potential environmental consequences for biological resources. Potential effects were predicted for biodiversity and for habitats or ecological associations of concern (see chapter V). Consequences were predicted for methyl bromide fumigation. In general, program use of methyl bromide is expected to result in little or no effects on human health or nontarget organisms. Refer to chapter V, Environmental Consequences, for a discussion on the potential of program use of methyl bromide to affect atmospheric ozone concentrations.

b. Nonchemical Control Methods

In general, the nonchemical control methods were determined to have minimal or no potential environmental effects. The minimal effects predicted were for program workers and were associated with their use of vehicles and equipment.

c. Combined Control Methods

The potential consequences of the combined control methods were determined to be related to their component control methods. The higher potential for environmental effects associated with combined controls (which can contain chemical and nonchemical control methods) were attributable to the chemical control components.

C. Alternatives in Detail

1. No Action

The no action alternative would be characterized by no APHIS participation in a Medfly control or suppression program. It would be speculative to predict or attempt to characterize APHIS' future role under a no action alternative, but such a role might range from basic consultation to other forms of cooperation short of becoming involved in a program. Similarly, the actions that would be taken by the states to counter future Medfly infestations would be unpredictable; their actions could range from full eradication programs to no action. Without the unifying effect of APHIS' involvement, the responses could be expected to be highly variable from state to state.

State plant protection agencies probably would respond to Medfly outbreaks according to their evaluations and perceptions of risk to their agricultural industries, resources, and human health. Similarly, grower groups, growers, and individuals would also respond to future Medfly infestations according to their own special interests; grower response could involve use of any available (at the time of program implementation) technologies, including use of chemicals to reduce Medfly levels below an (as yet undetermined) economic threshold. Working cooperative relationships between APHIS and other organizations could be affected, altering response capabilities to new pest outbreaks. Federal facilities for rearing sterile Medflies for control purposes would be affected by closings and redirections.

Under no action, the risk of Medfly spread and further infestations greatly increases. Federal quarantine actions that reduce the spread of Medfly by regulating or otherwise restricting movement of host produce might be rescinded or, at the least, diminished through lack of APHIS involvement. If no action or insufficient action were taken by the states, the spread of Medfly would be limited only by the proximity of host plants in suitable climate areas. Expansion of the range of Medfly in this manner would ultimately lead to extensive crop losses, lost domestic and foreign agricultural markets, and extensive uncoordinated pesticide use. If the United States were to become generally infested with Medfly and take no quarantine action for the pest, some host fruits and vegetables produced in countries infested with Medfly might be allowed entry into the United States, subject to restrictions for other pests.

If no action is taken to eradicate Medfly outbreaks and the Medfly is allowed to spread throughout its potential range in the conterminous United States, potential for environmental impact from the uncoordinated use of pesticides greatly increases. Annual pesticide usage on major crops can be estimated from the data presented in a supporting document "An Economic Impact Assessment of the Mediterranean Fruit Fly Cooperative Eradication Program," incorporated by reference. Based on estimated application rates (generally 1 to 2 lbs/acre), number of applications required, and crop acreages, annual pesticide usage would range between 18.2 to 36.5 million pounds per year (table III-4). Annual pesticide uses for eradication programs designed to prevent Medfly from gaining a foothold cannot be predicted with accuracy or compared with the above figures because of the uncertainties regarding the location and character of those programs. However, governmental pesticide use in Medfly eradication programs has been and can be expected to be less (by several orders of magnitude) than the uncoordinated pesticide use that would result if no action were taken and Medfly were allowed to spread throughout its potential range.

Table III-4. Estimation of Annual Nongovernment Pesticide Use Under the No Action Alternative

Commodity and State	Acres	No. Applications	Total Lbs.Used (@ 1 Lb/Acre	to	2 Lb/Acre)
Apple					
California	31,500	8	252,000	to	504,000
Georgia	2,800	6	16,800	to	33,600
South Carolina	4,200	6	25,200	to	50,400
Apricot					
California	16,000	4	64,000	to	128,000
Avocado					
California	74,100	8	592,800	to	1,185,600
Florida	9,000	6	54,000	to	108,000
Date					
California	5,100	8	40,800	to	81,600
Fig					
California	16,000	8	128,000	to	256,000
Grape					
Arizona	5,000	6	30,000	to	60,000
California	640,600	8	5,124,800	to	10,249,600
Georgia	1,800	6	10,800	to	21,600
South Carolina	320	6	1,920	to	3,840
Grapefruit					
Arizona	6,400	12	76,800	to	153,600
California	18,300	16	292,800	to	585,600
Florida	104,200	12	1,250,400	to	2,500,800
Texas	4,500	12	54,000	to	108,000
Kiwifruit					
California	7,500	8	60,000	to	120,000
Mango					
Florida	2,500	6	15,000	to	30,000
Nectarine					
California	25,500	8	204,000	to	408,000
Orange					
Arizona	10,200	12	122,400	to	244,800
California	178,100	16	2,849,600	to	5,699,200
Florida	420,900	12	5,050,800	to	10,101,600
Texas	3,500	12	42,000	to	84,000
Peach					
California	52,100	8	416,800	to	833,600
Georgia	21,000	6	126,000	to	252,000
South Carolina	30,200	6	181,200	to	362,400
Pear					
California	22,500	8	180,000	to	360,000
Pepper					
California	20,395	6	122,370	to	244,740
Florida	20,700	6	124,200	to	248,400
Louisiana	681	6	4,086	to	8,172
Texas	4,247	6	25,483	to	50,964
Plum and prune					
California	41,900	8	335,200	to	670,400
Tangelo					
Florida	8,000	12	96,000	to	192,000
Tangerine					
Arizona	4,000	12	48,000	to	96,000
California	7,500	16	120,000	to	240,000
Florida	8,700	12	104,400	to	208,800
Total Pesticide Used			18,242,659	to	36,485,318

2. Medfly Suppression (Including Chemicals)

Medfly suppression (including chemicals) would be characterized by APHIS participation in a program to reduce Medfly populations to some economically acceptable or insignificant level. Because Medfly eradication has always been the principal objective of previous Medfly control programs, there is no information available to support what an economically acceptable level of infestation might be. Under this alternative, APHIS and its cooperators would need to decide what constitutes an appropriate economic threshold and then suppress or control Medfly populations accordingly by employment of specific control methods, including the use of chemicals, as described in depth later in this chapter. Acceptance of a suppression program would mean allowance of the presence of continuously breeding Medfly populations in the conterminous United States. An ongoing suppression program also would require public acceptance of control activities over large areas.

APHIS' role and the dedication of its resources in the implementation of a Medfly suppression (with chemicals) program are undetermined. However, similar programs have not been initiated in Hawaii where the Medfly has become established. APHIS' level of involvement in such a suppression program would be dependent upon a number of factors, including the nature of the infestation, the technological capabilities of state cooperators, and the available resources. In the past, Medfly suppression was dismissed as an alternative by APHIS and its cooperators principally because it did not adequately protect U.S. agriculture and its markets.

Although Medfly suppression may not be considered appropriate by APHIS or its cooperators for a variety of reasons, Medfly suppression is examined as a reasonable alternative to no action or Medfly eradication. It is theoretically possible to take no action, eradicate Medfly, or suppress it to a predefined level. The uncertainty about the degree of control which might be considered necessary or optimum under a speculative suppression program renders it difficult to project such a program's intensity or potential environmental impacts. However, a basic consideration of a suppression alternative helps to provide a clearer basis for choice among alternatives for the program.

3. Medfly Suppression (No Chemicals)

Medfly suppression (no chemicals) would be characterized by APHIS participation in a program to reduce Medfly populations to some economically acceptable or insignificant level. Under this alternative, APHIS and its cooperators would need to decide what constitutes an appropriate economic threshold and then suppress or control Medfly populations accordingly using only the nonchemical control methods described in depth later in this chapter. Acceptance of a suppression program would mean allowance of the presence of continuously breeding Medfly populations in the conterminous United States.

APHIS' selection of control method(s) would be made according to existing conditions, so that this alternative could be implemented in an efficient and environmentally sound manner.

APHIS' level of involvement in a nonchemical suppression program would be dependent upon a number of factors, including the availability of control technology. the nature of the infestation, the technological capabilities of state

cooperators, and the available resources. (APHIS receives its resources for eradication programs through emergency funding; funding for nonemergency suppression programs could be extremely limited.) Regulatory efforts would be maintained; grower groups and individuals would be encouraged and required to comply with regulations designed to reduce the potential spread of Medfly.

APHIS and its cooperators are concerned that any Medfly suppression program will not fulfill the requirements of the Federal Plant Pest Act (7 United States Code (U.S.C.) 150) to destroy or dispose of any exotic plant pest that poses a threat to U.S. agriculture. Neither APHIS nor any of its cooperators have supported a Medfly suppression objective in the past. Nevertheless, consideration of this alternative helps to provide a clear basis for choice among options by the decisionmaker.

4. Medfly Eradication (Including Chemicals) —Preferred Alternative

The Medfly eradication (including chemicals) alternative would be characterized by APHIS participation in a cooperative program to eradicate Medfly, as determined in the Purpose and Need (chapter II) of this document. APHIS would participate with state plant protection organizations, as needed and as mandated by statutory authorities, to eradicate Medfly. Under this alternative, APHIS and its cooperators would accomplish eradication by employment of specific control methods, including the use of chemicals, as described in depth later in this chapter. APHIS would consider the specific conditions at the site of the outbreak in its selection of appropriate control methods.

APHIS' role in the eradication of Medfly may vary, depending upon factors such as the characteristics of the infestation (i.e., size, location, and potential for expansion), available resources of APHIS and the cooperators, existing cooperative agreements, grower involvement, and site-specific constraints (possibly influencing the division of labor between APHIS and its cooperators). For the purpose of this analysis, it is expected that APHIS will have a need to be involved in all aspects of future Medfly eradication programs. APHIS personnel and facilities, including sterile insect laboratories, would be managed in support of the eradication effort. Grower groups and individual growers would be required to cooperate in the regulatory program designed to prevent the spread of the Medfly by use of regulatory control methods.

Although there has been intermittent need for Medfly eradication programs, this eradication strategy minimizes the impact of the Medfly and the control methods used against it. Recurring Medfly eradication programs have been necessary because of repeated reintroductions of Medfly through various pathways from Hawaii and foreign countries, including the inadvertent movement or smuggling of infested fruit by travelers or in cargo. Even if Medfly became established as a permanent resident of the conterminous United States, it would still be a nonnative species that APHIS is authorized to eliminate because of the threat it would pose to U.S. agriculture.

5. Medfly Eradication (No Chemicals)

The Medfly eradication (no chemicals) alternative would be characterized by APHIS participation in a cooperative program to eradicate Medfly. In a hypothetical nonchemical eradication program, APHIS could participate with state

plant protection organizations, as needed and as mandated by statutory authorities, to eradicate Medfly. APHIS and its cooperators could employ only the nonchemical control methods described in depth later in this chapter. The selection of control methods would be made according to existing conditions, so that the eradication could be accomplished in an efficient and environmentally sound manner. Nonchemical regulatory efforts could be utilized; grower groups and individuals would be required to take actions to reduce the potential spread of Medfly.

The exact role of APHIS and its dedication of resources in the implementation of a nonchemical eradication program are undetermined. APHIS' participation and level of involvement in such a program would be dependent upon a number of factors, including the feasibility of the alternative, the nature of the infestation, the technological and logistical capabilities of cooperators, and the available resources.

Under this alternative, effective nonchemical control methods would be required to replace the customary use of chemicals for vital program components. Theoretically, if a sufficient number of sterile Medflies were available, malathion bait spray could be replaced with high overflooding ratios (proportion of sterile to feral or wild Medflies) of sterile Medflies, in combination with other control methods. Pilot studies in Hawaii on the island of Kauai have not been successful in reducing established Medfly populations with predetermined numbers of sterile flies. Even provided that the facilities were available, 3 weeks' time is required to increase production. Biologically, this lag time without an effective suppressant allows the Medfly reproductive cycle to continue, with additional opportunity for the infestation to grow larger and spread. Fruit stripping, nonchemical regulatory control methods, and other complementary control methods could also be used in this alternative.

D. Control Methods in Detail

The control methods that could be used in the Medfly Cooperative Eradication Program represent the means by which the program objectives may be met. Control methods can be employed individually and have been analyzed individually for that reason (see chapter V, Environmental Consequences). In general, while a single control method may be used within a limited geographical area (depending on host presence and other factors), it is unlikely that future programs will rely on only one method. Control methods are used more effectively when combined within integrated pest management. Although most of the control methods identified may be used for Medfly eradication or suppression, the determined objective could result in considerable differences in how they are used, the areas that would be targeted, and the amounts and duration of their use.

Selection of a control method (or methods) would depend ultimately upon the choice of alternative, and will take into account: proven efficacy, practicality, environmental risk, and flexibility. For a control method to be considered efficacious in this program, it must have been thoroughly tested and found to

be reliable under the broad range of conditions that might be expected in a potentially large-scale field program. APHIS and its cooperators support the need for continued research for Medfly technologies, especially environmentally benign forms of control, but must limit their control methods to proven ones for emergency programs such as this.

Most of the analyzed control methods have been demonstrated to be practical in previous cooperative Medfly eradication programs. The ability of agencies to respond with control methodologies can vary considerably over time, and with respect to available resources (funding, contract resources, sterile insect supplies, spray equipment and vehicles, and trained personnel).

The selection of control methods must take into account the potential effects on the human environment (the natural and physical environment and the relationship of people with that environment). Program managers require the flexibility to adjust or match control methods to reduce environmental risks based on the specific environmental conditions encountered in the program area. In particular, control methods that minimize adverse environmental effects for human and nontarget populations must be chosen, based upon the efficacy of the methods and sound scientific knowledge of the risks involved.

For a program where timing and emergency response is critical to success, program managers should have the flexibility to select a control method or combination of control methods that, in their judgment, responds best to the sum of influences (rather than just program efficacy or just environmental soundness). Considering the potential geographical scope of the program, it is likely that substantial program modifications may be necessary from one area to the next because of variance in state and local laws affecting the program, presence of different endangered and threatened species, or other site-specific characteristics.

APHIS continues to consider new and varied control methods (both chemical and nonchemical) in its efforts to comply with its statutory requirements to control the Medfly. In cooperation with the research arms of other Federal agencies (including the U.S. Department of Agriculture's Agricultural Research Service) and state agencies, it actively investigates and tests new and varied methods for dealing with the Medfly. APHIS uses the following as its criteria for selection of suitable control methods: efficacy, environmental soundness, availability, and cost.

1. Chemical Control

Specific chemicals have been proven to be effective for Medfly eradication or suppression and are considered for use in this program. This section describes the potential uses of the chemicals available for eradication or suppression treatments. Because most of the concern over chemical control methods is related to the chemicals that can be used for eradication or suppression treatments, this EIS focuses on the use of those chemicals.

Some, but not all, of the chemical control methods that can be used for eradication or suppression are also components of regulatory control (a combined control method). These control methods are used to allow certification and

movement in commerce of potentially infested articles. See the Regulatory Control section for a description of its component chemical control methods. Because of the unitized role of regulatory controls in most programs, regulatory controls are described as a unit in this EIS.

The chemicals considered for use in the Medfly eradication, suppression, and regulatory treatments are registered with the U.S. Environmental Protection Agency under requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 136) for the control of Medfly on host crops. The chemicals are registered under a regular registration (7 U.S.C. 136a), a registration for special local needs (7 U.S.C. 136v), or a registration limited to emergency actions (7 U.S.C. 136p). Because of differing state pesticide registration requirements, not all of the proposed chemicals are registered in the same way for each program state, and some chemicals may not be registered (and are therefore unusable) in certain program states.

Available chemical control methods target various life stages of the Medfly; for example, malathion bait sprays target the adult stage of the pest while diazinon soil drenches target the larval and emerging adult stages. Because of the reliance on chemicals to achieve immediate population reductions in eradication programs, any selection of alternative chemicals or nonchemical methods would need to be predicated on substantiated efficacy of the substituted method in that particular role. The availability of chemical control methods is subject to change, as currently available chemicals are phased out, as limitations are placed on their usage, and as new chemical control methods are developed.

Eradication and suppression chemicals include aerially applied baits, ground applied baits, and soil drenches. Table III-5 summarizes the chemicals used for control purposes. A brief discussion of the chemicals, their uses, and their potential environmental impacts follows. (Refer to the section on Regulatory Control, page 39, for a discussion of methyl bromide fumigation which is used exclusively as a regulatory treatment.)

Table III-5. Potential Chemicals for Eradication or Suppression

Treatment Method	Insecticide	Formulation Per Acre	Application Intervals	Targeted Medfly Life Stage	Application Target
Aerial (fixed-wing and rotary-wing aircraft) bait application	Malathion (ULV)[a] - with - protein hydrolysate bait (Nu-Lure®)	0.175 lb a.i.[b] 9.6 fl oz	5 to 21 days[c]	Adults	Plant foliage of host plants within 9 mi^2 (23 km^2) epicenter of infestation)
Ground bait application	Malathion - with - protein hydrolysate bait (Nu-Lure®)	0.175 lb a.i. 9.6 fl oz	5 to 21 days[c]	Adults	Plant foliage of host plants

continued

Table III-5, continued.

Treatment Method	Insecticide	Formulation Per Acre	Application Intervals	Targeted Medfly Life Stage	Application Target
Soil treatment	Diazinon - or - Chlorpyrifos - or - Fenthion	5 lb a.i. 1 to 4 lb a.i. 4 to 8 lb a.i.	14 to 16 days	Larvae, emerging adults	Soil within host plant's drip line

[a]ULV = Ultra Low Volume
[b]a.i. = active ingredient
[c]Dependent on temperature and weather conditions

a. Aerial Application of Malathion Bait

Aerial bait spray applications involve the use of malathion mixed with a protein hydrolysate bait to attract male and female adult Medflies. The Medflies feed on the bait spray. The malathion bait spray, a toxicant, reduces the wild Medfly populations to a level where sterile insect release can be an effective control method and usually is followed by sterile insect technique in integrated pest management in Medfly eradication programs.

A typical eradication program consists of two to four aerial applications of malathion bait spray followed by the use of sterile insect technique in a 9 mi^2 area around each Medfly find. Infestations that are heavy or widespread may require additional applications to lower populations to levels where release of sterile insects will be effective. Additional Medfly finds in baited traps may result in aerial application extending to areas surrounding the new Medfly detections. Containment and reduction of Medfly populations are both critical factors for eradication.

Full foliar coverage bait sprays of host trees and other plants immediately reduces adult Medfly populations by 90% or more and reduces subsequent reproduction. This decreases Medfly numbers in the succeeding generation and reduces the risk of gravid female Medfly movement to uninfested areas. In this manner, the bait spray reduces the wild Medfly population to a level of infestation where sterile Medflies can be effective in eradicating the rest of the population, including the parts of the population that were eggs, larvae, or pupae at the time of aerial application. The use of a bait to attract Medflies improves efficacy to the extent that the amount of malathion required is very low compared to labeled rates for most other uses.

b. Ground Application of Malathion Bait

Ground applications of foliar bait use the same materials as the aerial bait applications, differing only in that they are applied with ground equipment, such as human backpack sprayers or truck-mounted mist blowers and hydraulic sprayers. Bait spray droplets act as attractants and feeding stimulants (which increase the likelihood of the Medfly ingesting the toxicant). This application

Figure III-1. Helicopters are used to aerially apply malathion bait in some control programs. (Photo credit USDA, APHIS)

method, like the aerial application, is intended to reduce the wild Medfly populations to a level where the release of sterile Medflies can be an effective control method.

Generally, the spray is applied at close range to hosts in an area expanding outward from a Medfly detection until the designated area is treated. This greatly reduces the potential for Medfly to spread. Ground applications of foliar bait are usually applied as bait spot treatments, but could be applied as full coverage sprays. Because of the uncertainty of how they may be applied in a particular situation, this EIS analyzed the full coverage method which uses more material. Bait spot applications that use substantially less material would further reduce the potential for adverse environmental consequences.

Ground applications are preferable for small or isolated areas of host plants, locations adjacent to sensitive sites or water (where drift from aerial application could be a concern), and sites where aerial applications would be either

Figure III-2. In some programs, aerial applications of malathion bait are made at night to minimize disturbance to other human activities. (Photo credit USDA, APHIS)

less precise or unsafe. Although ground applications may provide better control of pesticide deposition than aerial applications and result in greater public acceptance, ground applications are more labor-intensive and may not be practical or even feasible in some areas. Insufficient coverage of the epicenter of a Medfly infestation results in risk of a gravid female Medfly locating a suitable host for oviposition without ever being attracted to the malathion bait spray. Thus, insufficient coverage could lead to establishment and further spread of Medflies.

c. Soil Treatment

Soil treatment with diazinon, chlorpyrifos, or fenthion is ordinarily used to kill Medfly larvae entering the soil and new Medfly adults emerging from the soil. It is used as a complementary control method, along with fruit stripping and other control treatments. Typically, one treatment (but up to three) may be made, applied directly to the soil within the drip line of host plants within the immediate vicinity of a Medfly larval detection. Because of its method of application (soil drench) there is no potential for drift.

d. Potential Future Chemical Controls

Boron, D-limonene, nontoxic high molecular weight proteins, and insect growth regulators are four examples of materials that have been suggested at various times for use against Medfly. However, these and other potential chemical

Figure III-3. Ground applications of malathion bait by backpack sprayer precisely target Medfly hosts. (Photo credit USDA, APHIS)

control methods share two main disadvantages: there is not enough information to judge their potential efficacy for large-scale programs, and information is incomplete or unavailable with respect to their potential environmental effects. The USDA's Agricultural Research Service is researching technologies and methods that show promise as future control methods.

2. Nonchemical Control

a. Sterile Insect Technique

The sterile insect technique (SIT) employs the release of sterilized Medflies into the infested area where they mate with the feral Medflies, producing only infertile eggs. If the sterile insects are released often enough and in sufficient numbers, the feral population will decline and eventually be eradicated. SIT has been proven effective against low-level Medfly populations where high overflooding ratios are easier to achieve. Generally, malathion bait spray is used to eliminate gravid Medfly females and achieve a low population density before SIT is employed. SIT is effective when a ratio of at least 100:1 sterile male Medflies to feral male Medflies is sustained. Increasing the ratio above 100:1 improves the effectiveness of the SIT technique. (That ratio is expressed in terms of sterile male numbers, although sterile releases include sterile females which also may contribute to the success of the technique.) Used in integrated pest management, SIT also affords continuing effectiveness on adults that emerge from the ground where they were not affected by earlier malathion bait sprays.

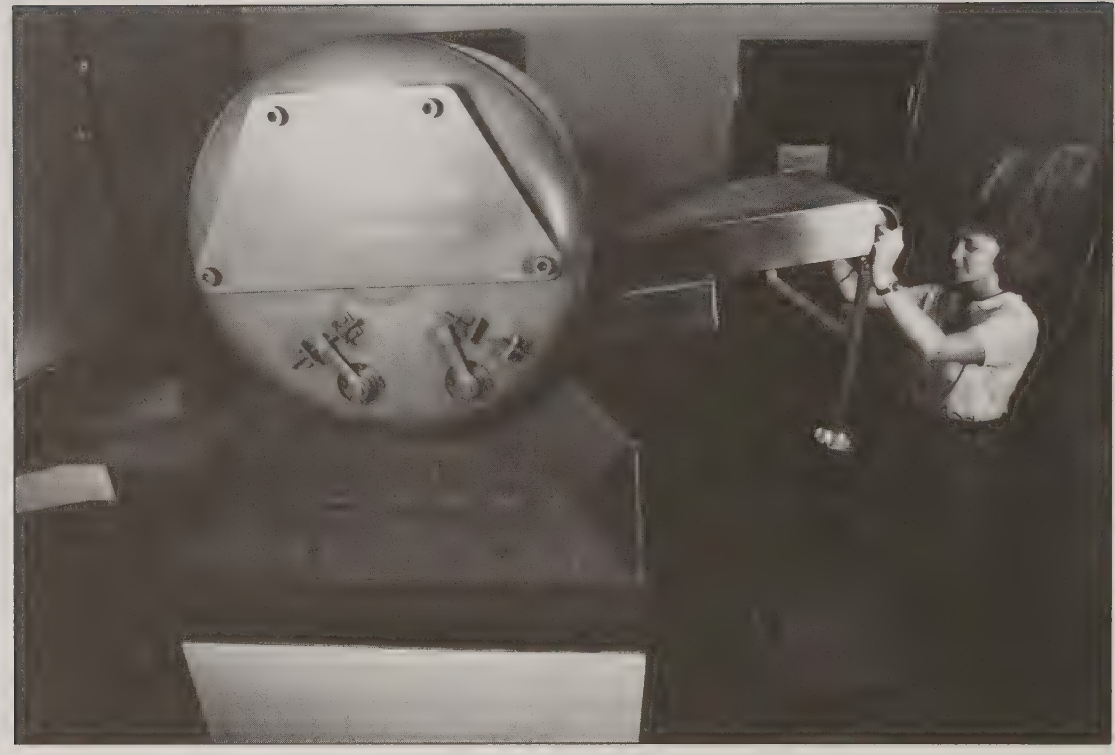


Figure III-4. Sterile Medfly production facilities use irradiators to sterilize laboratory-reared Medflies. (Photo credit USDA, APHIS)

Figure III-5. Sterilized Medflies are transported great distances by aircraft from the production facility to the program release area. (Photo credit USDA, APHIS)

Figure III-6. In the sterile insect technique, sterile Medflies are released to mate with wild Medflies, which then produce only infertile eggs. (Photo credit USDA, APHIS)

For the program, most sterile Medflies would be produced at the rearing facilities in Waimanolo, Hawaii. Alternate sources for flies include the rearing facilities in Honolulu, Hawaii, San Miguel Petapa, Guatemala, and Metapa de Dominguez, Mexico. In sterile production, the Medfly eggs hatch into larvae that feed on an artificial diet medium. The pupae that develop are irradiated with gamma rays 2 to 4 days prior to adult emergence and placed in containers where the adults emerge. The sterile adults are held for 24 to 48 hours before release from aircraft or ground vehicles.

Safety guidelines are followed by the sterile insect laboratories in all steps of sterile insect production. Irradiation equipment is checked on a regular basis and no problems associated with its use has been known to occur. The irradiated insects are not radioactive and pose no problem to the environment.

Figure III-7. Sterile Medflies may be released from aircraft or the backs of trucks, as shown here. (Photo credit USDA, APHIS)

SIT can be a very effective control method. In combination with carefully coordinated malathion bait spray applications, SIT has been a principal tactic used in most recent successful Medfly eradications. However, SIT alone was attempted for Medfly eradication in the fall of 1980 in Santa Clara County, California; there, sole reliance on SIT was unsuccessful because the feral population was too high and the necessary release ratio of 100:1 could not be maintained. As a result, the Medfly population and the infested area expanded, requiring use of alternative control methods, including malathion bait spray.

b. Physical Control

The physical control method involves physical actions taken to eliminate Medfly hosts or host produce. Fruit stripping and host elimination are two types of physical control methods that can be employed. Fruit stripping is routinely employed in Medfly eradication programs. The physical elimination of Medfly hosts also may be especially helpful in the elimination of small, isolated infestations. In general, the physical control method is normally used in combination with other control methods in integrated pest management.

In the beginning of a program, trapping and subsequent fruit cutting may determine that a site is infested with Medfly. All host fruits on the infested properties and those immediately adjacent are stripped promptly and disposed of properly. The area stripped of host fruit normally includes all properties within 200 meters (656 feet) of the confirmed larval site. The host fruit may

Figure III-8. The Steiner trap (made of plastic) is used to monitor the effectiveness of the sterile insect technique. (Photo credit USDA, APHIS)

be destroyed by burial, incineration, or a combination of both methods at an approved landfill or refuse site. If buried, the fruit is covered with at least 45.7 centimeters (18 inches) of soil. This control method does not destroy or prevent dispersion of the adults which are already present and does not affect the number of Medflies emerging from pupae already in the ground. Thus, properties with confirmed larval infestations require chemical treatment of the host plants and soil, as well as fruit stripping and cutting. The logistic aspects of collecting and disposing of the fruit also limit its operational use. The limitations of physical control make it most effective when used as a complementary control method for Medfly.

Although the goal of host elimination is the same as fruit stripping, its methods and effects differ substantially. In a moderate scenario, host elimination might mean the removal of only a few plants from an urban environment. In a more extreme scenario, host elimination could involve destruction of numerous wild Medfly host plants. This control method might target both native (e.g., various persimmon, *Diospyros* spp.) and escaped exotics (e.g., feral citrus trees). This could result in a substantial potential for adverse environmental effects from removal and/or destruction of entire plants (especially trees and woody shrubs) in natural areas. Control of Medfly in commercial plantings would require a method other than host elimination, obviously. With fruit stripping, only the actual host material (the fruit) is removed, causing little or no detrimental effect to the health of the plant. Except in very limited circumstances, host elimination is unacceptable because of environmental considerations, time constraints, and resource concerns.

c. Cultural Control

Cultural control reduces pest populations through manipulation of agricultural practices. In general, agricultural practices are modified to make the crop environment as unfavorable as possible for the insect pest. Cultural control methods frequently include: clean culture, special timing, trap cropping, use of resistant varieties, crop rotation, varying plant locations, and manipulation of alternate hosts. Several of these methods (but not all) have applicability for control of Medfly and are discussed here. However, they are of limited effectiveness and are most useful as complementary control methods for Medfly.

Clean culture, or careful and complete harvesting combined with destruction of infested and unmarketable Medfly host crops, can be important in reducing Medfly populations. Collecting and burying host fruit left after harvest, destroying damaged fruit, and removing unwanted or wild alternate hosts in and around fields, are often recommended for suppressing Medfly infestations. By collecting and destroying potential Medfly host fruit, the developing eggs and larvae in the fruit are eliminated as well as the host fruits which are a possible source of continued infestation.

Special timing could be employed in some geographical regions by scheduling the planting of short-season fruit and vegetable crops so that fruit ripening does not coincide with peak Medfly activity or by harvesting the fruit before it reaches a stage of ripeness highly susceptible to Medfly attack. Although this technique theoretically could reduce Medfly populations, it is not likely that enough control could be exercised over commercial agricultural practices to make it effective or worthwhile. Also, the presence of multiple hosts in most potential locations for Medfly infestation limit the applicability of this method.

Trap cropping involves the planting of a crop that is favored by the pest in order to attract and concentrate the pest in a limited area where the pest can be destroyed by chemical or cultural methods. For other insect pests, trap cropping often involves planting a small plot of the favored host crop prior to the main crop so that overwintered life stages of the pest will be concentrated and destroyed by pesticides or by plowing the crop under before the main crop is infested. It is unlikely that this method could be applicable to the program because of the perennial nature of many host species, the availability of other host species in the program areas, and the lack of data on effectiveness of trap crops in attracting Medflies from distant areas.

Resistant varieties may be of some future benefit in helping to prevent Medfly infestations. Some reduction in risk of Medfly infestation could be achieved through public response to a public information program designed to illustrate the value of and recommend the selection of plant varieties that are nonhosts or are partially resistant to the Medfly. Mechanisms that serve as a basis for host plant resistance to the Medfly have been demonstrated in some host plants (Greany et al., 1983; Eskafi, 1988). As with special timing, however, it is not likely that sufficient control could be exercised over the commercial agricultural industry or homeowners to make this control method worthwhile (it is not

likely that industry would restrict its selection of varieties on the basis of a potential threat).

Crop rotation and varying the locations of plantings have little applicability to this program. Most of the important host species are perennials and would not be moved around or rotated with other crops.

d. Male Annihilation

Male annihilation, a control method also referred to in some other programs as mass trapping, reduces Medfly populations by attracting Medflies to brightly colored panels where they are trapped and die before they have the opportunity to mate. The panels are bright yellow and have a sticky surface to trap the Medflies. The effectiveness of the panels is often enhanced by baiting them with a synthetic lure, trimedlure or ceralure, applied directly to the panels or to wicks attached to the panels. Because the baits attract the male Medflies, the control method has been termed male annihilation. Large numbers of panels must be placed within and surrounding the infestation area for the method to be effective. Male annihilation would be used to lower the population of Medflies to levels where eradication could be achieved through the combined use of other control methods such as sterile insect technique.

The use of panels and lures to control fruit flies is a relatively recent development that is still being tested and improved. It has been used effectively against other fruit flies, such as the melon fly in El Segundo, California, in 1987. Tests conducted with the panels indicate that few nontarget arthropods are attracted by the panels. Placement of the panels in host trees out of reach of the public makes it unlikely that the public would be exposed to the lures or sticky panels. The low toxicity of the lures and sticky chemical result in negligible risk to humans, livestock, or pets as a consequence of any expected exposure.

There are some limitations to the use of male annihilation. This approach is costly and labor-intensive. It may require placement and servicing of 1,000 or more panels per square mile within the infestation area. Effectiveness is reduced if panels are dislodged and inadvertently destroyed by the public, livestock, or pets. Panels are believed most effective when new infestations are detected and combined control methods are used, but are believed ineffective as a male annihilation technique for large populations where the male Medflies have mated prior to being trapped by the panel.

e. Biological Control

Biological control (biocontrol) is the reduction of pest populations by means of living organisms encouraged by humans (Pfadt, 1971). Biocontrol differs from natural control of pest organisms in that human intervention is involved in the dissemination of the pest's enemies (parasites, predators, and pathogens). APHIS and its cooperators have utilized successfully biocontrol agents in many insect and weed pest control programs. However, even though a number of organisms have been investigated as potential biocontrol agents against the

Medfly (see table III-6), biocontrol has not been utilized for any previous emergency Medfly eradication program. There are a number of reasons for this, including unproven efficacy and lack of immediate results for large scale emergency Medfly eradication programs.

Table III-6. Organisms Reviewed for Use as Potential Biocontrol Agents of the Medfly

Name	Type of Organism	Targeted Medfly Life Stage
Parasite		
Steinernema carpocapsae (formerly S. feltiae)	Nematode	Larvae, pupae, and adults
Parasitoids		
Diachasmimorpha tryoni (formerly *Biosteres tryoni*)	Braconid wasp	Larvae, pupae
Psyttalia humulis	Braconid wasp	Larvae
D. longicaudatus (formerly *Biosteres longicaudatus*)	Braconid wasp	Larvae, pupae
Testrastichus giffardianus	Eulophid wasp	Larvae
Pathogens		
Bacillus thuringiensis	Bacteria	Adults
Picornavirus (V)	Virus	Adults
Reovirus (I)	Virus	Adults
Predators		
Iridomyrmex humilis	Argentine ant[1]	Larvae
Solenopsis geminata	Fire ant[1]	Larvae
Pheidole megacephala	Bigheaded ant[1]	Larvae
Zygoptera	Zygopteran damselfly	Adults
Mantidae	Praying mantis	Adults
Staphylinidae	Staphylinid beetle	Larvae
Vespidae	Vespid wasp	Adults

[1]Potential biocontrol agents that are themselves pests and, therefore, unacceptable for use in this program.

APHIS believes that modern biological control, appropriately applied and monitored, is an environmentally safe and desirable form of long-term management of pest species. It is neither a panacea nor a solution for all pest problems. APHIS believes that biological control is preferable when applicable, but recognizes that biological control has limited application to emergency eradication programs. Whenever possible, biological control should replace chemical control as the base strategy for integrated pest management (Melland, 1992).

Although of questionable use for emergency eradication programs, biocontrol may have greater potential for use in a Medfly suppression program, especially in the role of complementary control, where it might reduce or help to reduce Medfly populations so that other control methods can be more effective. Although optimally used as a complementary control method, biocontrol alone may offer promise for suppression programs, depending upon the degree of Medfly control that would be acceptable.

If biocontrol of the Medfly could be demonstrated to be efficacious and reliable, a number of advantages might be attributed to its use in a Medfly control program. Biocontrol can be self-perpetuating under conditions where populations of the host or an alternate host remain and where climatic conditions allow the biological agent to overwinter. Even under conditions that would not allow a self-perpetuating population of biocontrol agents, inundative releases might still be of value in reducing Medfly populations. In the public's perception, biocontrol is often preferred over other forms of control methods because it is thought to involve little or no environmental impact. The greatest value of biocontrol agents may be in situations where immediate results or containment of the pest population are not the overriding concerns. The Agricultural Research Service is working to develop a biocontrol approach to reducing Medfly and other fruit fly species populations in Hawaii. This could contribute to ultimate eradication of those pests in Hawaii, thereby reducing risk of spread to the conterminous United States.

In spite of its advantages, biocontrol has major limitations which influence its suitability for eradication or suppression programs, including: lack of immediate results; potential lack of effectiveness; logistical difficulties; and incomplete or unavailable information about rearing techniques, natural dispersal, and affects on nontarget species.

Biocontrol's results are achieved over a protracted timeframe. Since most of the organisms that parasitize or prey on Medfly target its immature stages, the extant adult population would be able to continue reproducing and have the potential to move or be carried to other areas to spread the infestation. This characteristic would be undesirable for Medfly eradication programs where the objective is to destroy the Medfly before it can reproduce further and be carried or blown out of the area.

Biocontrol agents normally are not capable of achieving total elimination of a pest species, but instead reduce pest populations by varying percentages. Generally they reduce pests to lower levels (often to the point where the pests become hard for them to find), thereby reducing economic impact of the pest, but they seldom are capable of killing all of the pest population. If that were to happen, the biocontrol agent would destroy itself in the process; natural mechanisms usually prevent this. The nature of eradication programs (early detection and an immediate response to eliminate Medfly populations before they grow large) and the relatively low pest populations tend to limit the effectiveness of biocontrol.

Biocontrol may be difficult to apply on a large-scale basis. It is often expensive and labor intensive to rear large quantities of organisms for biocontrol programs. Biocontrol agents usually must be reared on the pest host (increasing pest risk), and often the agents' life cycles (long generation times and few offspring) complicate rearing operations. It is often difficult to maintain large numbers of biocontrol agents on hand in anticipation of program needs. Biocontrol organisms are often fragile, requiring special protection prior to release. Also, biocontrol methods are often incompatible with chemical control methods.

Lastly, there are many unknown factors about biocontrol of the Medfly. This control method might require massive releases of exotic organisms into the environment of the conterminous United States. For some biocontrol organisms, not much is known about the potential environmental impacts of their use, especially on nontarget species. The efficacy and the impacts of releases on a large scale may be speculated upon, but are largely unknown at this time.

The information relevant to reasonably foreseeable significant adverse impacts of this control method is not available because the technology is not ready for program implementation; because the technology is not ready, information relative to its environmental impact is therefore not essential to a reasoned choice among alternatives. No body of credible scientific evidence relative to evaluating the impacts of this control method exists or can be summarized within this document, and APHIS cannot evaluate the method's impacts based on theoretical approaches.

f. Biotechnological Control

Biotechnological control is the use of genetic engineering techniques to control a pest like the Medfly. Currently, there are four primary areas of genetic engineering that show promise for control of insect pests: (1) bioengineering of crop plants (insertion of specific genes into the plants to improve plant characteristics such as pest resistance), (2) improvement of insect-infecting viruses, (3) production of genetic mutations of the pest (thereby affecting its reproductive capabilities) by radiation or other means, and (4) gene probe techniques to screen for insecticidal properties in micro-organisms.

Biotechnological control is a potential future control method, but is not considered ready for use now because: (1) the technology is still in its infancy and is not immediately adaptable for this program; (2) bioengineering has not been exploited for Medfly control purposes (e.g., bioengineered Medfly host plants such as citrus are not yet available and, even when they become available, replacement of stands will require years) (Moore and Cline, 1989); (3) commercial insect-infecting viruses are not available for Medfly and effectiveness as an eradication method has not been proven; (4) no rearing facilities are currently available for production of genetic mutations of the pest; (5) other techniques for inheritable sterility are still in the development stage; (6) screening done for new strains of bacteria against Medfly is only the first step in basic research and development of insect-infecting micro-organisms; and (7) the information relative to the environmental impacts of bioengineered organisms is incomplete and unavailable.

The information relevant to reasonably foreseeable significant adverse impacts of this control method is not available because the technology is not ready for program implementation; because the technology is not ready, such information relative to its environmental impact is therefore not essential to a reasoned choice among alternatives. No body of credible scientific evidence relative to evaluating the impacts of this control method exists or can be summarized

within this document, and APHIS cannot evaluate the method's impacts based on theoretical approaches.

3. Combined Controls

a. Regulatory Control

In a Medfly eradication program, regulatory controls are established as part of a major integral regulatory component, designed to prevent the spread of Medfly from the infested area. To accomplish this, APHIS and its cooperators designate a quarantine area based on the extent of the infestation and regulate the movement of commodities from that area. At the beginning of a program, a quarantine notice is published in 7 Code of Federal Regulations (CFR) 301.78 (Domestic Quarantine Notices, Subpart–Mediterranean Fruit Fly). This notice establishes the quarantine area, designates articles that are regulated under the quarantine (Medfly itself, Medfly hosts, and other articles that could harbor Medfly), and establishes procedures for the movement of such articles from the quarantine area.

Upon detection of an infestation, all growers and establishments that grow, handle, or process regulated articles grown within the area of the epicenter of the infestation are issued Emergency Action Notifications. If necessary, the Deputy Administrator, Plant Protection and Quarantine, APHIS, may direct the field officers to initiate specific emergency action under the Federal Plant Pest Act (7 U.S.C. 150dd) until Federal regulations can be published in the Federal Register. State and local cooperators are informed of the detection, the actions contemplated, and the actions taken. Other procedural guidance is

Figure III-9. Regulatory quarantines help to deter the spread of Medfly by humans. (Photo credit USDA, APHIS)

provided in the USDA, APHIS, Action Plan, Mediterranean Fruit Fly *Ceratitis capitata* (Wiedemann) (1989).

The regulatory actions necessary to prevent the spread of Medfly are dependent on the extent and location of the infestation. Localized, light infestations may require minor regulation of industries such as fruit producers or local retail fruit stands. Heavy or widespread infestations, however, may require mandatory checks of passenger baggage at airports and the use of road patrol checkpoints to monitor quarantine boundaries. Regulatory actions may also be required at properties of local growers, packing houses, landfills, freight companies, post offices, flea markets, produce markets, farmers' markets, transportation depots, canneries, and other produce processing establishments. Adequate disposal of regulated articles at landfills to eliminate pest risk may be particularly important. Regulatory treatments may be performed to allow movement of certain regulated commodities out of the quarantine area. Records are main tained for each regulatory action taken in compliance with the promulgated quarantine regulations.

The interstate movement of certain regulated commodities originating in areas quarantined for Medfly infestations requires (under 7 CFR Part 301) the issuance of a certificate or limited permit. The issuance of a certificate or limited permit is contingent on grower or shipper compliance with certain conditions, based on the situation and characteristics of the regulated article(s). In general, treatments are required (table III-7) to preclude possibility of transmittal of live Medfly stages. Each of those treatments is described in further detail in this section. The Plant Protection and Quarantine Treatment Manual (USDA, APHIS) provides greater detail of the treatments, including treatment schedules, procedures, equipment, and safety precautions. The manual, which is periodically revised to provide current recommendations, is incorporated by reference in this EIS.

The USDA Agricultural Research Service conducts research to develop more efficacious and species-specific regulatory and eradication techniques. This research includes evaluation of new chemical and nonchemical treatments to control Medfly. APHIS determines the acceptability of these treatments for program regulatory control methods after reviewing their efficacy data, applicable environmental analyses, operational compatibility, and any other pertinent documentation.

(1) Fumigation

Methyl bromide fumigation is used as a regulatory control method to kill Medfly in regulated articles and allow the movement of those regulated articles from within the quarantine area to locations outside the quarantine boundaries. The program's methyl bromide fumigations comply with the pesticide label and with all Federal, state, and local regulations. All fumigations are done under strict supervision within the quarantine area. Methyl bromide fumigation may also be combined with cold treatment to fulfill requirements for certifying some commodities free of Medfly.

Methyl bromide is an efficacious, broad spectrum pesticide that is widely used as a fumigant to control insects, nematodes, fungi, rodents, and weed seed. It is characterized by rapid dissipation following treatment and proper aeration, nonflammable and nonexplosive properties, and stability in gaseous form to relatively low temperatures (down to 4 °C (39 °F)).

Table III-7. Regulatory Controls

Method	Insecticide	Formulation	Treatment Interval or Duration	Targeted Medfly Life Stage	Application Target
Bait spray application	Malathion (95% technical grade) - with - protein hydrolysate bait (Nu-Lure®)	0.175 lb a.i.[a]/acre 9.6 fl oz/acre	6 to 10 days	Adults	Regulated commercial crops that will be harvested for later movement outside of quarantine area[b]
Soil treatment[c]	Diazinon - or - Chlorpyrifos - or - Fenthion	5 lb a.i./acre 1 to 4 lb a.i./acre 4 to 8 lb a.i./acre	14 to 16 days (up to 3 applications per season unless infestation is established)	Larvae, emerging adults	Soil within host plant drip line of regulated nursery stock grown within quarantine areab
Fumigation	Methyl bromide	32 g/m^3	Up to 6 hours at 21°C (70°F)	Eggs, larvae	Certain approved host commodities
Cold treatment[d]	N/A	N/A	3 to 16 days at -3 to 3°C (27 to 37°F)	Eggs, larvae	Certain approved host commodities
Vapor heat treatment	N/A	N/A	Up to 8¾ hours at 44.4°C (112°F)	Eggs, larvae	Certain approved host commodities
Hot water treatment	N/A	N/A	30 minutes at 42°C (107.6°F) followed by 20 minutes at 49°C (120.2°F)	Eggs, larvae	Papaya, mango

[a]a.i. = active ingredient.
[b]Outside infested core area.
[c]Used after nursery stock is stripped of fruit.
[d]If used after fumigation, time lapse between treatments must not exceed 24 hours.

Figure III-10. One of the requirements of fruit stands regulated under a Medfly quarantine is to cover Medfly host produce with netting to deter oviposition by Medfly. (Photo credit USDA, APHIS)

(2) Soil Treatment

Soil treatment (diazinon, chlorpyrifos, or fenthion drench) is a regulatory control method used to kill Medfly in regulated soil and allow the movement of that regulated soil from the quarantine area. Soil treatment is used often to establish freedom from living stages of the pest in soil associated with regulated nursery stock. Together with fruit stripping, it provides the basis for certification of the nursery stock for movement.

Soil treatments are applied as drench applications to an area within the drip line of the host plants using ground equipment. Applications are limited to the soils of regulated nursery stock grown within the quarantined area. Generally, no more than three applications are made within the drip line of host plants at 14 to 16 day intervals per season.

(3) Bait Spray Application

Malathion bait spray is used as a regulatory control method to establish freedom of nursery or orchard premises from living stages of Medfly, as a condition for movement of produce. To accomplish this, the establishment undergoes a series of malathion bait spray treatments at intervals, designed to provide continued freedom from Medfly during the quarantine period. Bait spray applications are limited to locations producing regulated commodities within the quarantined area, but located outside the infested core area. Treatments must start a sufficient time, at least 30 days, before harvest (to span the interval that would normally include the completion of egg, larval, and pupal

development) then continue throughout the harvest period. The required preharvest treatment makes this option useful for only those commodities remaining in the field for more than 30 days after the area is quarantined for Medfly.

(4) Cold Treatment

Cold treatment is used to kill Medfly in regulated articles as a prerequisite for movement of those articles out of the quarantine area. Cold treatment is preferable to fumigation for those commodities that are sensitive to methyl bromide. Cold treatment may also be combined with methyl bromide fumigation as an authorized regulatory treatment for some commodities.

All cold treatments are conducted in approved facilities under strict supervision. The facilities must be within the quarantine area and the cold treatments must be completed before commodities are moved from the quarantine area. The regulatory cold treatments are commodity-specific and are described in detail in the Plant Protection and Quarantine Treatment Manual (USDA, APHIS).

The necessary restrictions (duration of treatments and approval for facilities) and availability of facilities for cold treatments are likely to limit the use of this treatment in the regulatory program.

(5) Vapor Heat Treatment

Vapor heat treatment is another regulatory control method used to kill Medfly in regulated articles to allow movement of the regulated articles outside of the regulated area. Program vapor heat treatments must be conducted in an approved facility and are strictly supervised. The facility must be within the quarantine area and the heat vapor treatment must be completed prior to moving the commodity from the quarantine area. These treatments are described in detail in the Plant Protection and Quarantine Treatment Manual (USDA, APHIS). This treatment can only be used for certain heat tolerant commodities. Vapor heat treatment probably would not be used often as a control method because of the lack of facilities in the quarantine area.

b. Integrated Pest Management

Integrated pest management (IPM) has been defined variously by different authors, based on their professional perspectives. In 1972, the Council on Environmental Quality adopted the following definition of IPM: "Integrated pest management is the selection, integration, and implementation of pest control actions on the basis of predicted economic, ecological, and sociological consequences" (CEQ, 1972). The classical notion of IPM involves the use of any or a combination of control methods, including biological controls, cultural controls, chemical controls, and other controls.

If IPM were selected, the program would use singly, or in combination, any of the following components: chemical control, sterile insect technique, physical control, cultural control, and regulatory control. Each of the control methods is considered in detail in its own section of this analysis. (Refer to Cumulative

Impacts in chapter V, Environmental Consequences, for analysis of the effects of combined uses of control methods.)

As defined and as considered within this EIS, IPM can be used for Medfly eradication or suppression programs. IPM has also been defined as ". . . a pest control strategy based on the determination of an economic threshold that indicates when a pest population is approaching the level at which control measures are necessary to prevent a decline in net returns—that is, when the predicted value of the impending crop damage exceeds the cost of controlling the pest" (NRC, 1989). If used for Medfly suppression, IPM would have the objective of managing or reducing the Medfly populations to below some predetermined economic threshold. For a suppression program, then, that economic threshold would determine the degree of control that is required, thereby influencing program operations, the selection of component control methods, and the resulting environmental consequences.

In general, IPM offers an optimum combination of program efficacy and maximum environmental protection. The selection of a particular control method or combination of methods for an individual site would take into consideration several factors, including economic (the cost effectiveness of various methods in both the short and long term), ecological (the impact on nontarget organisms and the environment), and sociological (the acceptability of various IPM methods to cooperators and/or the public).

Using IPM, the program would vary its use of control methods to protect human health, nontarget species (including endangered and threatened species), sensitive areas, and other components of the environment within the potential program area. Program managers also would utilize specific protection measures and/or mitigations in combination with their selection of those control methods to maximize efficacy and minimize environmental risk. Provided that the potential environmental effects of the IPM components have been analyzed and that necessary protective measures are employed, maximum flexibility can be afforded the program manager for the selection of control methods to fit the situation.

Although many favor IPM because they consider it more environmentally sound than other types of control methods, they frequently misunderstand the nature of IPM. It is not simply biological control or the use of any single technique. IPM is often confused with organic gardening, a method that does not use synthetic chemicals. The purpose of IPM is not to avoid the use of chemicals, but to use the most effective or environmentally sound pest control technique or combination of techniques for long-range pest control (CEQ, 1972).

IV. The Affected Environment

A. Introduction

The Medfly Cooperative Eradication Program has the potential to affect the environments of future program areas. The environments are complex and diverse, with characteristics and components that can influence the implementation of future Medfly programs. Factors considered by program planners include the physical environment, biological resources, human population, cultural resources, and visual resources.

The geographical scope of the program is based on factors related to host range, climate, potential avenues of introduction, and past introductions. Parts of the potential program area share common characteristics, especially with regard to physical character and biological resources.

For purposes of discussing the affected environment, the environmental impact statement (EIS) considers six ecological regions (ecoregions) which encompass the program counties of the nine-state program area. The physical and biological components of these ecoregions are developed within this chapter. Such an organization facilitates a broad perspective of the environment, as required for a programmatic EIS, while allowing a focus on essential aspects of the environment that may be affected.

B. Environmental Characteristics of the Potential Program Area

1. General Characteristics

Although future Medfly programs may occur anywhere within a broad geographical area, past Medfly introductions suggest that future programs will probably involve areas where human activity occurs. Such areas may be urban, suburban, or agricultural in character, and characterized by considerable modification of natural features and processes.

In urban and suburban areas, topography and vegetation have been modified to accommodate buildings and transportation corridors. Landscaping has changed vegetation patterns and species composition. Runoff has increased because of channelized water courses and impervious cover material, which may exceed 40% of the area (McBride and Reid, 1988). Loss of habitat and urban pesticide treatments (such as for mosquitoes by health departments) have altered populations of pest species and other insects.

Land in agricultural production is usually intensively managed and monotypic. Orchards, for example, generally contain a single crop species planted in uniform, evenly spaced rows, often with a single species of ground cover between the crops. Physical alteration, fertilization, irrigation, routine use of a variety of pesticides, and other agricultural practices have altered the structure and function of the natural environment. Fertilizers and herbicides have altered geochemical cycles in both urban and agricultural areas (Brady et al., 1979).

Urban, suburban, and agricultural lands may include (or may be interspersed with) natural areas such as parks, forests, lakes, and refuges. Often, the transition between the natural areas and the other lands is not distinct.

The physical and biological characteristics of the area, the agricultural practices, and the changes that are brought about by humans, all influence the environmental consequences of a Medfly program.

2. Ecoregions of the Potential Program Area

The potential program area is considered within the framework of six ecoregions. Refer to figure IV-1 for a general map of the six ecoregions and the states included in each. These ecoregions have been adapted from several classification systems now in use (USDA, SCS, 1981; Omernik, 1986; Bailey, 1980; Kuchler, 1964; and Brown et al., 1977):

California Central Valley and Coastal ecoregion includes southern coastal and south-central valley areas of California; for the purposes of this EIS, the Sierra Nevada range (usually considered part of this ecoregion) has been omitted because it is an area unlikely to continuously support Medfly populations.

Southwestern Basin and Range ecoregion spans program areas in Arizona and southeastern California.

Lower Rio Grande Valley ecoregion in Texas is bounded on the east by the gulf coastal plain and on the south by the Rio Grande River. It marks the southern terminus of the central Texas plains and includes potential program areas in southern Texas.

Southeastern and Gulf Coastal Plain ecoregion is a low-lying area bounded by the Atlantic Ocean, the rolling hills of the southeastern plains, the Gulf of Mexico, and the southwestern plains. It includes potential program areas within Alabama, Georgia, Mississippi, South Carolina, and Texas.

Mississippi Delta ecoregion includes potential program areas in the Mississippi River Delta area of Louisiana.

Floridian ecoregion includes most of peninsular Florida. Potential program areas are found in the southern half of the State.

C. Physical Environment

A general description of the physical environment of the entire potential program area (climate, land resources, water resources and quality, and air quality) follows. More detailed information on the physical characteristics of the area may be found in tables IV-1 through IV-6, for each ecoregion, according to major land resources subregions. The subregions are depicted in figures IV-2 through IV-4, which precede the tables.

1. Climate

The climate of the potential program area varies from the Mediterranean climate of California, to the hot climate of the southwestern desert regions and the lower Rio Grande Valley, to the cooler climate of the mountain and foothill

Figure IV-1. **Ecoregions of the Medfly Cooperative Eradication Program Area**

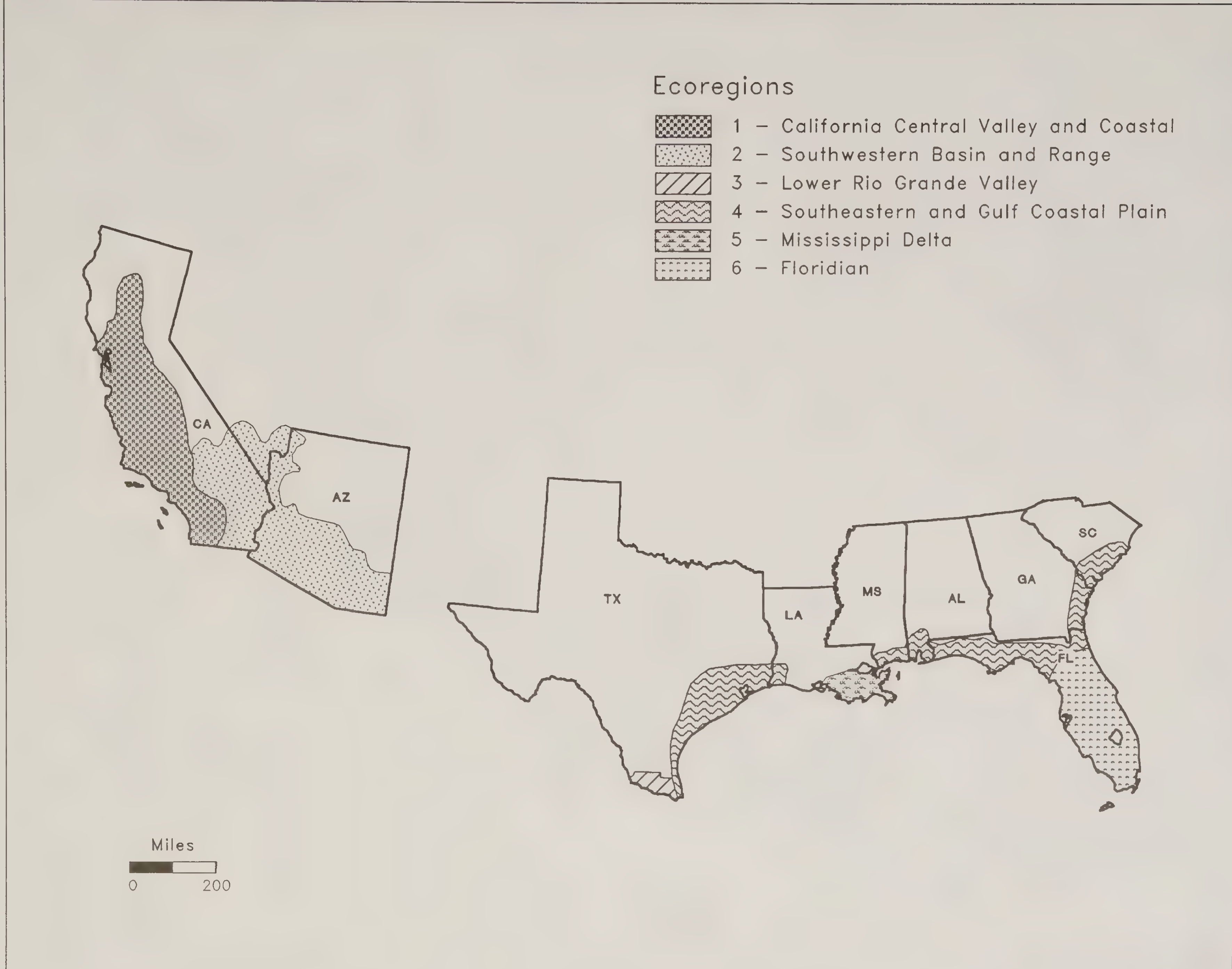


Figure IV-2. **Land Resource Subregions of the Medfly Cooperative Eradication Program Area**

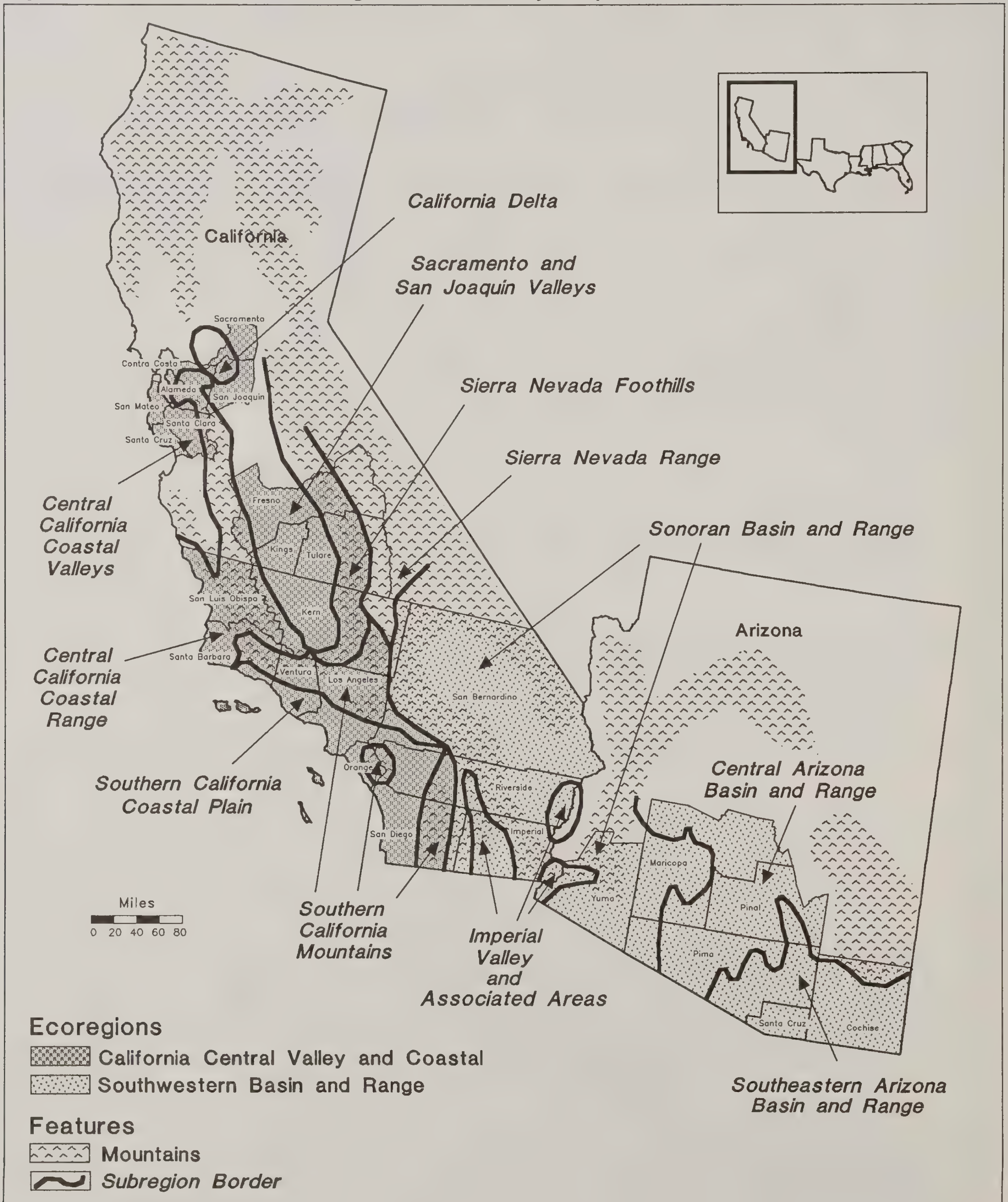


Figure IV-3. **Land Resource Subregions of the Medfly Cooperative Eradication Program Area**

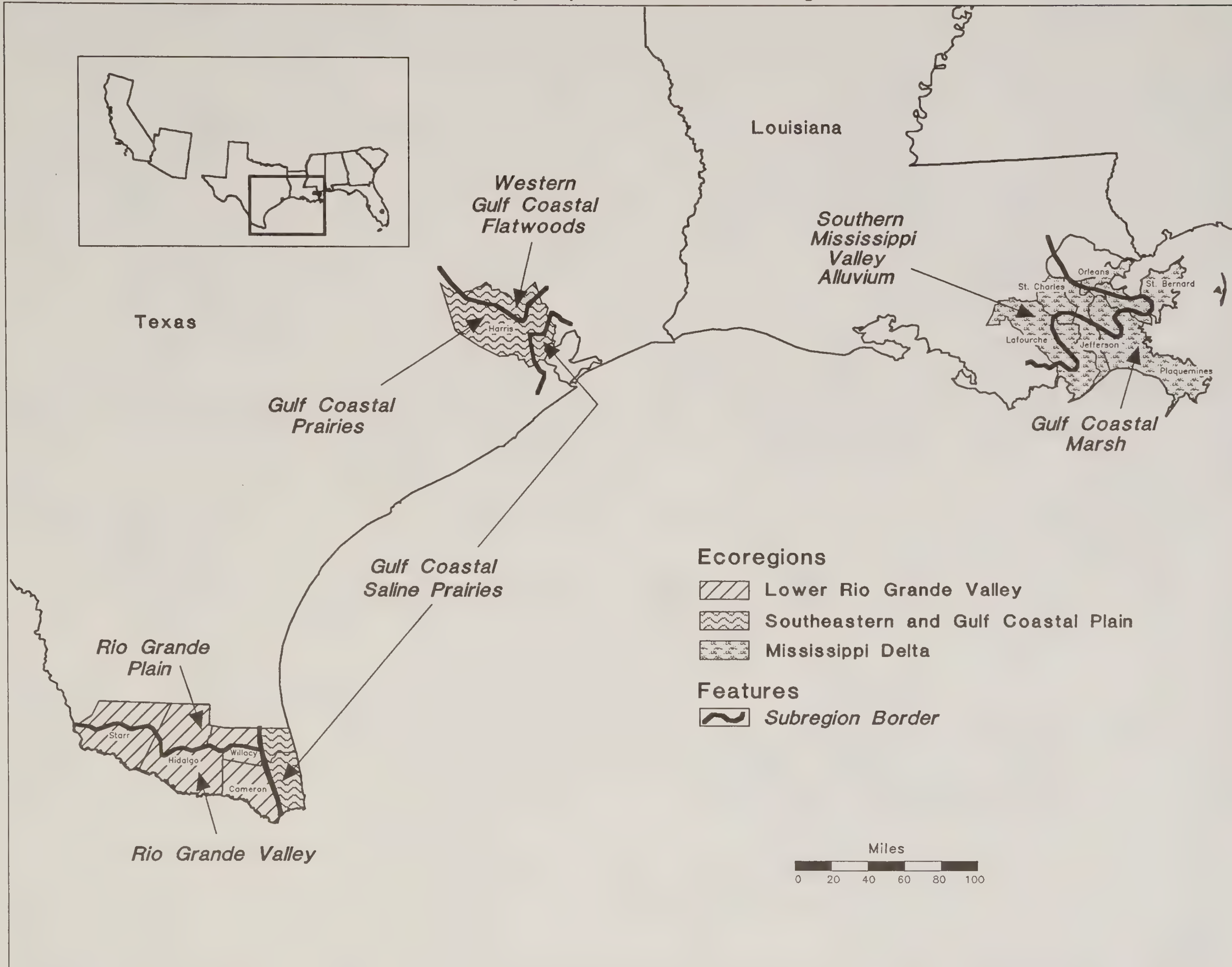


Figure IV-4. **Land Resource Subregions of the Medfly Cooperative Eradication Program Area**

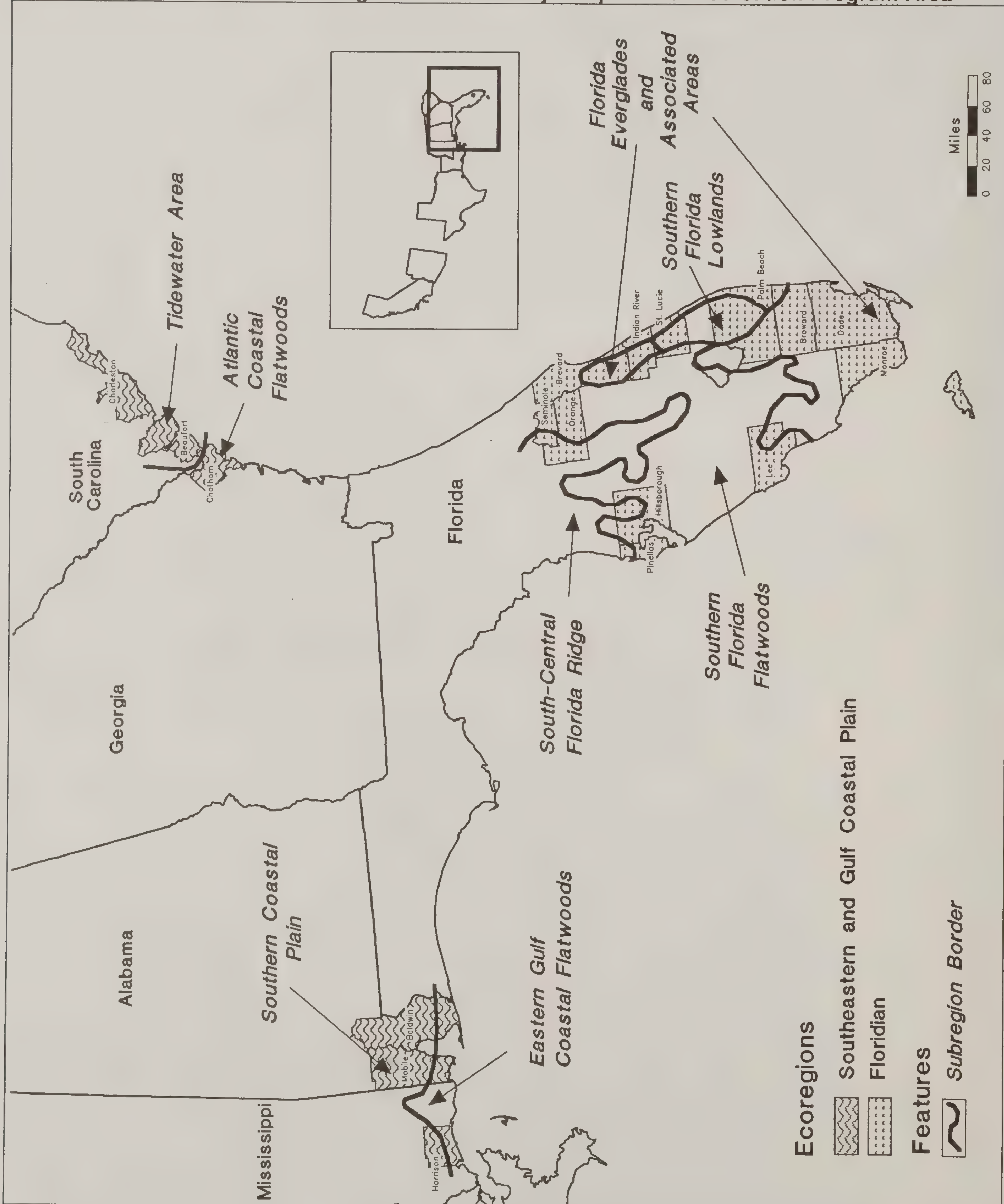


Table IV-1. Land Resources and Characteristics

California Central Valley and Coastal Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ----- Rainfall Distribution	Avg. Annual Temperature ----- Freeze-free Period	Freshwater Resources	Soils	Potential Areas of Medfly Introduction
Central California Coastal Valleys	Farming (including dairy), crops (wine grapes, strawberries and other fruits, cut flowers, small grains, hay), pasture, ranches, urban development, wildlife habitats, salt ponds, recreation	Sea level to 600 m (1,969 ft); mostly less than 300 m (984 ft)	300 to 750 mm (12 to 30 in) ----- Precipitation very low mid-spring to mid-autumn	15°C (59°F) ----- 210 to 300 days	Moderate rainfall and local streamflow (inadequate for needs), San Lorenzo River	Alkaline to acid pH, sandy or gravelly loams to clay	Cities: Oakland and San Jose
Central California Coastal Range	Farming and ranching (80%), Federal property, open woodland, forests, urban areas	Sea level to 800 m (2,625 ft), up to 1,500 m (4,922 ft) in some mountains	300 to 1,025 mm (12 to 40 in) ----- Precipitation evenly distributed throughout fall, winter, and spring; low in summer	16°C (61°F) ----- 120 to 270 days	Low to moderate rainfall; moderate streamflow; Nacimiento and San Antonio Reservoirs; Salinas River	Acid to alkaline pH, sandy loam to clay	City of San Luis Obispo
California Delta	Farming (including asparagus, sugar beets, potatoes, corn, grain, hay), fruit trees, recreation, wildlife habitat, pasture	Below sea level to slightly above sea level	325 to 375 mm (13 to 15 in) ----- Dry summers	16°C (61°F) ----- 270 days	Sloughs and waterways, Sacramento River	Moderately alkaline to strongly acid pH, silty clay to clay	City of Stockton
Sacramento and San Joaquin Valleys	Farming (fruits, nuts, citrus, grapes, melons, tomatoes, cotton, hay, grain, rice), pasture	Sea level to 200 m (656 ft)	125 to 625 mm (5 to 25 in) ----- Dry summers, rainy winters	18°C (64°F); 13°C (55°F) in northern area ----- 230 to 350 days	Low rainfall; small streamflow; irrigation from state and Federal water systems; California Aqueduct; and groundwater. Canals: Friant-Kern, Delta-Mendota; Lakes: Tulare, Buena Vista; Rivers: San Joaquin, Kern.	Slightly acid to moderately alkaline pH, sandy loam to clay, some saline soils	City of Sacramento

continued

Table IV-1, continued.

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ----- Rainfall Distribution	Avg. Annual Temperature ----- Freeze-free Period	Freshwater Resources	Soils	Potential Areas of Medfly Introduction
Sierra Nevada Foothills	Ranching (75%), farming (5%) (fruit, nuts, grapes), brushland, open forest	200 to 500 m (656 to 1,641 ft), up to 1,200 m (3,937 ft) on mountain peaks	350 to 900 mm (14 to 35 in) ----- Dry summers, moist winters	16°C (61°F) ----- 200 to 320 days	Moderate rainfall, intermittent streamflow; storage or local watershed; and groundwater.	Neutral to moderately acid pH, sandy or sandy clay loam with some rocky or cobbley sandy loam	
Southern California Coastal Plain	25% Federal property, 20% urban, 33% brushland, 10 to 20% cropland (subtropical and deciduous fruits, grain, truck crops, grapes, hay), pasture, dairy farming, flower seed production	Sea level to 600 m (1,969 ft)	250 to 625 mm (10 to 25 in) ----- Dry summers, fog provides moisture along the coast	17°C (63°F) ----- 250 to 365 days	Low rainfall, intermittent streamflow. Colorado River Aqueduct, Los Angeles Aqueduct, and California Aqueduct. Rivers: San Diego, Santa Margarita.	Neutral to strongly acid pH	Cities: Anaheim, Los Angeles, Riverside, San Diego. Port: San Diego.
Southern California Mountains	40% Federal property, 5% urban, farming (fruit, grain, hay, citrus, vegetables, flowers), range, pasture	600 to 2,400 m (1,969 to 7,874 ft),up to 3,000 m (9,843 ft) peaks	400 to 1,025 mm (16 to 40 in) ----- Dry summers, some snow in winter	16°C (61°F) ----- 100 to 200 days (250 days in western area)	Moderate rainfall, deep sand and gravel deposits in valleys yield water, Colorado River Aqueduct. Rivers: Los Angeles, Santa Ana.	Neutral to moderately alkaline pH, sandy loams to clay	City and Port of Los Angeles

Source: *Land Resource Regions and Major Land Areas of the United States (Agriculture Handbook 296)*

Table IV-2. Land Resources and Characteristics

Southwestern Basin and Range Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ----- Rainfall Distribution	Avg. Annual Temperature ----- Freeze-free Period	Freshwater Resources	Soils	Potential Areas of Medfly Introduction
Sonoran Basin and Range	80% Federal property, 20% local government property, recreation, range, wildlife habitat, irrigated crops (vegetables, fruits, nuts, citrus, grapes, cotton, small grains, grain sorghum, hay, pasture)	100 m (328 ft) below sea level to 1,200 m (3,937 ft) above sea level, up to 3,400 m (11,155 ft) in mountains	50 to 250 mm (2 to 10 in) in valleys, up to 625 mm (25 in) on mountain slopes ----- Even precipitation distributed throughout year	20°C (68°F), as low as 10°C (50°F) in mountains ----- 240 to 320 days	Large springs, wells. Rivers: Gila and Colorado	Neutral to alkaline pH, loamy sand to cobbly or gravelly sandy loam	
Imperial Valley and Associated Areas	Farming (irrigated crops--citrus, dates, grapes, sugar beets, vegetables, small grains, flaxseed, hay, tame pasture grasses), ranching, recreation, wildlife habitat, urban development	50 m (165 ft) below sea level to 200 m (656 ft) above sea level	50 to 100 mm (2 to 4 in)	23°C (73°F) ----- 280 to 350 days	Wells, Imperial Reservoir. Rivers: Gila and Colorado	Alkaline pH, sand to silty clay loam, some stony	Yuma
Central Arizona Basin and Range	Farming (irrigated crops--cotton, alfalfa, barley, other small grains, lettuce, carrots, cabbage, cauliflower, other vegetables, melons, citrus), ranching, wildlife habitat, urbanization	300 to 1,100 m (984 to 3,609 ft)	125 to 300 mm (5 to 12 in) ----- Most precipitation July through September, and December through March	20°C (68°F) ----- 250 to 300 days	Deep wells, Lake Pleasant. Rivers: Agua Fria, Gila, and Santa Cruz	Alkaline pH; sandy loam to clay, some gravelly	Phoenix
Southeastern Arizona Basin and Range	Community development, range, recreation, wildlife habitat, irrigated crops (cotton, corn, alfalfa, small grains, lettuce, and other crops)	800 to 1,400 m (2,625 to 4,593 ft)	275 to 375 mm (11 to 15 in) ----- Most precipitation July through September	15°C (59°F) ----- 150 to 250 days	Groundwater, artesian flows. Rivers: Santa Cruz and San Pedro	Moderately alkaline pH, sandy loam to gravelly clay loam	Tucson

Source: *Land Resource Regions and Major Land Resource Areas of the United States (Agriculture Handbook 296)*

Table IV-3. Land Resources and Characteristics

Lower Rio Grande Valley Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation - - - - - Rainfall Distribution	Avg. Annual Temperature - - - - - Freeze-free Period	Freshwater Resources	Soils	Potential Areas of Medfly Introduction
Rio Grande Valley	Ranching (beef cattle), wildlife habitats, crops (cotton, grain sorghum, onions, cabbage, citrus and other fruits, warm and cool season vegetables, melons, sugarcane)	Sea level to 300 m (984 ft), mostly less than 100 m (328 ft)	425 to 700 mm (17 to 28 in) - - - - - Maximum precipitation is during the growing season	23°C (73°F) - - - - - 300 to 330 days	Rainfall, deep wells and ponds, various oxbow lakes, Falcon Reservoir, Rio Grande River	Moderately alkaline to slightly acid pH, sandy loam to clay loam	Cities of Brownsville and Harlingen
Rio Grande Plain	Ranching (beef cattle), wildlife habitats, crops (grain sorghum, cotton, and small grains for grazing)	25 m (82 ft) to 200 m (656 ft)	425 to 650 mm (17 to 26 in) - - - - - Maximum precipitation is during the growing season	22°C (72°F) - - - - - 260 to 325 days	Rainfall, deep wells and ponds, Rio Grande River	Moderately alkaline to slightly acid pH, sand to sandy clay loam, some gravelly	

Source: *Land Resource Regions and Major Land Resource Areas of the United States (Agriculture Handbook 296)*

Table IV-4. Land Resources and Characteristics

Southeastern and Gulf Coastal Plain Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ----- Rainfall Distribution	Avg. Annual Temperature ----- Freeze-free Period	Freshwater Resources	Soils	Potential Areas of Medfly Introduction
Gulf Coastal Saline Prairies	Ranching, urban, recreation, rice, grain sorghum, wildlife refuges	Sea level to 3 m (10 ft), occasional coastal dunes to 8 m (26 ft)	750 to 1,400 mm (30 to 55 in) ----- Evenly distributed throughout year	22°C (72°F) ----- 250 to 330 days	Rainfall, streams, ponds, Rio Grande River	Alkaline pH, clay to sand (often saline)	Port of Brownsville
Gulf Coastal Prairies	Farming (rice, row crops, cotton, and hay); range or pasture; forestry; urban	Sea level to 50 m (164 ft)	625 to 1,400 mm (25 to 55 in) ----- Slightly higher in winter	21°C (70°F) ----- 280 to 320 days	Rainfall, perennial streams, ground-water, San Jacinto River	Neutral to alkaline pH, clay	City and Port of Houston
Western Gulf Coastal Flatwoods	Forestry (75%) (used for lumbering), rice, pasture, row crops, urban	25 to 100 m (82 to 328 ft)	1,175 to 1,400 mm (46 to 55 in) ----- Slightly higher in winter	20°C (70°F) ----- 260 to 280 days	Rainfall, perennial streams, ground-water, Lake Houston, San Jacinto River	Acid pH, sand to loam, high water tables	
Eastern Gulf Coastal Flatwoods	Forestry (used for lumbering), state and national forests, 4% crop, 4% pasture	Sea level to 25 m (82 ft)	1,325 to 1,625 mm (52 to 64 in) ----- Maximum in summer	20°C (70°F) ----- 270 to 290 days	Rainfall, perennial streams, groundwater (may be affected by salt). Rivers: Dog, Escatawpa, Fowl, Middle, Spanish, Tchoutacabouffa, Tensaw, Wolf	Acid pH, sandy, coastal soils: sandy to organic	Cities: Mobile, Biloxi, Gulfport. Ports: Mobile and Gulfport.
Southern Coastal Plain	69% woodland, row crops, melons, vegetables, cereals, range, pasture, urban development	25 to 200 m (82 to 656 ft)	1,025 to 2,525 mm (40 to 99 in) ----- Maximum in winter and spring	18°C (64°F) ----- 200 to 280 days	Rainfall, perennial streams, ground-water, reservoirs	Acid pH, loamy or sandy (often clay subsoil)	
Atlantic Coastal Flatwoods	Forestry (70%), wildlife refuges, vegetables, fruits, cereals, row crops, peanuts	25 to 50 m (82 to 164 ft)	1,025 to 1,400 mm (40 to 55 in) ----- Maximum in summer	17°C (63°F) ----- 200 to 280 days	Rainfall, perennial streams, ground-water. Rivers: Ogeechee, Vernon Savannah.	Acid pH, sand to clay, organic soils	City and Port of Savannah

continued

Table IV-4, continued.

Subregion	Land Use	Elevation/ Topography	Annual Precipitation - - - - - Rainfall Distribution	Avg. Annual Temperature - - - - - Freeze-free Period	Freshwater Resources	Soils	Potential Areas of Medfly Introduction
Tidewater Area	Forestry (70%), wildlife refuges, pasture, recreation, row crops, tobacco, vegetables	Sea level to 25 m (82 ft)	1,150 to 1,275 mm (45 to 50 in) - - - - - Maximum in summer	19°C (66°F) - - - - - 200 to 300 days	Rainfall, perennial streams, groundwater. Rivers: Ashley, Cooper, Coosaw, Edisto, Stono, Wando, Broad.	Acid pH, some organic soils, soils often wet	City and Port of Charleston

Source: *Land Resource Regions and Major Resource Areas of the United States (Agriculture Handbook 296)*

Table IV-5. Land Resources and Characteristics

Mississippi Delta Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation - - - - - Rainfall Distribution	Avg. Annual Temperature - - - - - Freeze-free Period	Freshwater Resources	Soils	Potential Areas of Medfly Introduction
Gulf Coastal Marsh	Marsh vegetation for wildlife habitat; pasture, rice	Sea level to 2 m (7 ft), salt dome islands up to 50 m (164 ft)	1,224 to 1,650 mm (48 to 65 in)	21°C (70°F) - - - - - 280 to 350 days	Rivers, lakes, bayous, manmade canals. Rivers: Atchafalaya and Mississippi	Alkaline pH, organic and often saline, often marshy	City and Port of New Orleans
Southern Mississippi Valley Alluvium	Woodland, pasture, crops (cotton, rice, soybeans, wheat, sugarcane), wetland wildlife areas	Sea level to 20 m (65 ft), mostly flatland, level to gently sloping flood plains and low terraces, swamps	1,150 to 1,650 mm (45 to 65 in)	18°C (64°F) - - - - - 250 to 340 days	Precipitation, streamflow, groundwater in northern Louisiana, oxbow lakes, bayous, Mississippi River	Acid pH, silt loam to clay	City and Port of New Orleans

Source: *Land Resource Regions and Major Land Resource Areas of the United States (Agriculture Handbook 296)*

Table IV-6. Land Resources and Characteristics

Floridian Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation - - - - - Rainfall Distribution	Avg. Annual Temperature - - - - - Freeze-free Period	Freshwater Resources	Soils	Potential Areas of Medfly Introduction
Florida Everglades and Associated Areas	50% Indian reservations, national parks, and game refuges; 35% forest and recreation; 13% crops (winter vegetables, citrus fruits, avocado, papaya, sugarcane), urban development	Sea level to less than 25 m (82 ft)	1,275 to 1,625 mm (50 to 64 in) - - - - - Maximum precipitation in late spring through early autumn	24°C (75°F) - - - - - 330 to 365 days	Rainfall, surface water, groundwater, marsh, Everglades, St. John's River	Organic soils, some with tidal flooding	Everglades. Cities: Miami, Ft. Lauderdale. Port: Miami.
Southern Florida Lowlands	Farming and ranching; 20% forest; 20% crops (citrus fruits, vegetables, and other cultivated crops), range, pasture; saltwater marsh	25 m (82 ft), mostly flat area	1,325 to 1,525 mm (52 to 60 in) - - - - - Maximum precipitation in summer	23°C (73°F) - - - - - 330 to 360 days	Rainfall, surface water, and groundwater	Neutral to strongly acid pH, sand to loamy sand	
South-Central Florida Ridge	40% forest, 25% pasture, 5% crops (citrus, vegetables), urban development	25 to 50 m (82 to 164 ft), some hills up to 100 m (328 ft)	1,275 to 1,400 mm (50 to 55 in) - - - - - Maximum precipitation in summer	22°C (72°F) - - - - - 290 to 350 days	Rainfall, groundwater, lakes, few perennial streams, Lake Apopka	Acid pH, sandy to sandy loam	Orlando
Southern Florida Flatwoods	65% forest, 15% pasture, 15% native range, 3% crops (mainly winter vegetables, citrus and other subtropical fruits)	Sea level to 25 m (82 (ft)	1,300 to 1525 mm (51 to 60 in) - - - - - Maximum precipitation in summer	22°C (72°F) - - - - - 290 to 365 days	Rainfall, surface water, groundwater. Rivers: Caloosahatchee, Kissimmee, Peace, Withlacoochee; Lakes: Istokpoka, Kissimmee, Okeechobee	Acid pH, sandy	Cities: Tampa, Clearwater, St. Petersburg, West Palm Beach. Port: St. Petersburg.

Source: *Land Resource Regions and Major Land Resource Areas of the United States (Agriculture Handbook 296)*

regions of California and Arizona. Annual precipitation varies from less than 15 cm (6 in) in the Sonoran Basin and Imperial Valley in Arizona and California, to 251 cm (99 in) in the southern coastal plain. The climate affects soils, vegetation, and wildlife that are indigenous to individual areas as well as land resources, socioeconomics, and human populations in potential program areas. Degradation of residues from potential program pesticide applications generally would be greater in areas with higher rainfall and temperatures. In general, warmer temperatures and longer freeze-free periods allow Medfly populations to increase more rapidly with resultant increased potential for spread.

2. Land Resources

The topography of the potential program area varies from the level to slightly rolling gulf coast, to steep regions of the Sierra Nevada Foothills. Elevations range from 24 m (80 ft) below sea level in the deserts of California to about 1,372 m (4,500 ft) in the Southwestern Arizona Basin and Range ecoregion. Soil reaction ranges from mainly acid in the east to mainly alkaline in the west. Introduced Medfly populations would not be expected to survive at high elevations. Degradation of residues from potential program pesticide applications would be expected to occur more quickly at lower elevations. Varied topography and cropping patterns provide more host crops and microclimates that contribute to enhanced Medfly survival and spread.

3. Water Resources and Quality

Water availability varies greatly across the potential program area, ranging from very abundant in Florida and the eastern gulf coast, to extremely scarce in the desert regions of the west. The more mountainous areas are characterized by natural lakes and large, deep reservoirs. Groundwater is abundant in the valleys and is used for irrigation and livestock production. Water supply is low to moderate in the prairie subregions. Surface lakes, shallow wells, and streams in these areas are used for irrigation and watering of animals. Intermittent waters, such as seasonally flooded impoundments, are important breeding grounds as well as migration stops for waterfowl and other wetland species. The southwest and intermountain areas and California's Sacramento and San Joaquin Valleys are characterized by low precipitation and inconstant water sources. Water for irrigation and livestock comes primarily from the few reservoirs and large rivers. Potential contamination of surface water and groundwater resources by program pesticides could be a hazard to both wildlife and human populations. Because of agricultural and other uses, low-level background residues of certain pesticides in water are common in some areas. Therefore, cumulative effects of the program use of pesticides must be considered.

4. Air Quality

In general, the air quality of most of the potential program area is good. Most air pollution problems occur in industrialized and urban areas in the eastern States. The air quality of most of the western States is relatively good because of low population densities and lack of polluting industries. The major air quality problems that do occur in the west are confined to the urban areas of southern California (such as Los Angeles) and the smelter industrial areas of southeast Arizona. Some undesirable conditions are also associated with

agricultural activities and urbanization in central California. Because of agricultural and other uses, low-level background residues of certain pesticides in air are common in some areas. Therefore, cumulative effects of the program use of pesticides must be considered.

Reduced air quality (smog) affects visibility, which is especially valued for some areas. The U.S. Environmental Protection Agency (EPA) has identified special class I areas (national parks and wilderness areas) and vistas outside class I areas where visibility is an important value. The best visibility (more than 113 km (70 mi)) exists in the mountainous southwest, while the Pacific coastal regions have the worst visibility (16 to 40 km (10 to 25 mi)). The potential for toxic air pollution resulting from agricultural and urban pesticide use remains a concern of the general public.

D. Biological Resources

The biological resources of the potential program area include the plants, animals, and micro-organisms that are found there. These organisms exist as individuals, populations, and multispecies-species communities. They are dynamic, interactive components of their ecosystems which undergo structural and functional change, and vary with location and over time. A broad consideration of the biological environment promotes understanding of the biological systems which are exposed to program operations and facilitates a more detailed analysis of the organisms or systems which might be at risk from those operations.

1. Domestic Animal and Plant Species

Medfly eradication efforts typically occur in urban, suburban, and agricultural areas. Domesticated species which may be exposed to program operations include dogs, cats, tropical pet birds, and in some locations, livestock and poultry. Goldfish or koi ponds and stock ponds occur in some locales. Commercial aquaculture enterprises may rear fish or crustaceans in natural or artificial impoundments and are of major regional importance.

Backyard gardens occur throughout the program area. Annuals (such as peppers and tomatoes) as well as perennials (such as citrus and avocado trees) are commonly grown. Many of these are Medfly hosts. Medfly hosts grown as commercial crops in the program area include apricots, peaches, and citrus. Ornamental plantings around homes and along highways often include nonnative pollution-tolerant species.

2. Wild Animal and Plant Species

The numbers and kinds of wildlife associated with particular habitats depend on the season and on land resources. Typical species include a variety of invertebrate fauna, birds (American kestrels, European starlings, barn swallows, meadowlarks, and other songbirds), mice and other rodents, rabbits, raccoons, skunks, opossums, foxes, bats, and in some areas, coyotes.

Throughout the program area, soil and sediment support a great diversity of organisms which may inhabit the surface layer, occur beneath leaf litter or detritus, or are distributed throughout several layers. Earthworms and

microorganisms inhabit the soil; many insects spend portions of their life cycles as larvae or pupae in soil and sediments. These species provide food for a variety of fish, birds, and small mammals.

Water birds including ducks frequent lakes, ponds, and reservoirs throughout the program area. Introduced and native fish (including shiners, sunfish, bass, and catfish) occur in these water bodies as well as canals. Commercial and sport fishing occur throughout the program area.

Representative species for each ecoregion are presented in tables IV-7 through IV-12. A sampling of typical species is analyzed in the nontarget risk assessment (incorporated by reference). The assessment serves as the basis for an evaluation of potential environmental consequences of the Medfly eradication program.

3. Habitats of Concern

Aquatic habitats within the program area are of special concern because of the vulnerability of aquatic species to program pesticides, especially malathion. These habitats support a variety of endangered and threatened species, particularly in more arid program areas. Estuaries are spawning and nursery grounds for many marine and anadromous fish, as well as crustaceans and mollusks. They support a high density and diversity of birds as well as plankton which provides the base for many food webs. Sediments contain a variety of macroinvertebrate species, many of which are sensitive to program pesticides. In addition, intermittent streams and ponds are seasonally important as breeding and egg development habitat for amphibians and as reservoirs for migratory waterfowl, and often contain a variety of rare plants.

There is some disagreement as to the precise definition of a jurisdictional (regulated) wetland. Whether broadly or narrowly interpreted, there is consensus that wetlands are extremely valuable ecosystem components. They provide wildlife habitat, flood control enhancement, water quality improvement, sediment stabilization, nutrient transformation, and groundwater recharge/discharge. Degradation of water quality in any aquatic or wetland habitat could disrupt food webs and have serious implications for composition, density, and diversity of invertebrate, fish, and bird species.

The eastern coastal plain wetlands have been designated by the U.S. Department of the Interior's Fish and Wildlife Service (FWS) as Habitats of Special Concern because of their value to migrating birds and as breeding grounds for shorebirds. The Mississippi Delta as a whole is adversely affected by the high rates of erosion and submergence caused, in part, by human alteration of the natural drainage systems. The wetlands of the delta are designated as Habitats of Special Concern for waterfowl.

Much of the southern tip of Florida is occupied by Everglades National Park, Big Cypress National Preserve, and several smaller state and private wildlife refuges. The Everglades ecosystem is unique in North America and many species are threatened or endangered. Water management projects have altered the timing and quantity of freshwater flow and preservation of the Everglades ecosystem relies on the supply of high quality water from the north. Runoff

Table IV-7. Biological Resources

California Central Valley and Coastal Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Grassland	Brome, fescue, wild oats	Pocket gopher, California vole, mule deer, coyote, California ground squirrel, black-tailed jackrabbit	Western meadowlark, savannah sparrow, American kestrel, horned lark, western kingbird, killdeer	Gopher snake, grasshoppers, spiders	Valuable for wintering birds; introduced grasses predominate; converted to agriculture and rangeland.
Scrubland	Interior: chamise, California lilac, toyon. Coast: coyote brush, purple and black sage, coastal sagebrush, scrub oak.	Brush rabbit, brush mouse, dusky-footed wood rat, bobcat, gray fox	California quail, California thrasher, rufous-sided towhee, sage sparrow, wrentit	Western rattlesnake, coast horned lizard, alligator lizards, common kingsnake	Interspersed with urban areas near coast; development threatens southern sage scrub.
Woodland	Valley oak, interior live oak, blue oak, coastline oak, California buckeye, Engelmann oak	Mule deer, raccoon, striped skunk, bobcat, western gray squirrel, deer mouse	Acorn woodpecker, plain titmouse, western bluebird, American crow, scrub jay	Arboreal salamander, slender salamanders, alligator lizards, western fence lizard, ring-necked snake	Variety of wildlife foods; some southern woodlands reduced by development.
Aquatic	Fresh marsh: cattail, sedge, bulrush. Salt marsh: salt grass, pickleweed, frankenia.	Muskrat, beaver	Great blue heron, red-winged blackbird, marsh wren, mallard, Virginia rail	Garter snakes, red-legged frog, western toad, Pacific tree frog, California newt, mosquitofish, California killifish, bluegill	Especially valuable for wintering waterfowl; coastal marshes sometimes near urban areas.

Table IV-8. Biological Resources

Southwestern Basin and Range Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Mojave and Sonoran Deserts	Joshua tree, ocotillo, Mojave yucca, California juniper, saltbush, spiny sage brush, creosote bush, saguaro, cholla cactus, burro bush	Antelope squirrel, kangaroo rats, black-tailed jackrabbit, round-tailed ground squirrel, kangaroo rats, cactus mouse, desert mule deer, coyote, desert pocket mouse	Scott's oriole, white-winged dove, greater roadrunner, Gila woodpecker, cactus wren, LeConte's thrasher, common poorwill, Gambel's quail, elf owl	Chuckwalla, fringe-toed lizards, zebra-tailed lizard, side-blotched lizard, shovel-nosed snake, glossy snake, western whiptail	Slow to recover from disturbance, e.g., off-road vehicle use
Wash	Mesquite, catclaw acacia, smoke tree, blue palo verde, ironwood	Bailey pocket mouse, white-throated woodrat, javelina, mule deer, coyote	Black-throated sparrow, verdin, black-tailed gnatcatcher	Red-spotted toad, spade-foot toads, desert spiny lizard, brush lizard, horned lizards, tiger rattlesnake	Desert wildlife concentrates here
Riparian/aquatic	Willow, sycamore, cottonwood, saltcedar	Striped skunk, ring-tailed cat, raccoon, deer mouse	Summer tanager, Lucy warbler, ladder-backed woodpecker, yellow-billed cuckoo, green-backed heron, mallard	Western diamondback rattlesnake, spiny soft shell turtle, Colorado River toad, red-side shiner, Gila topminnow, bluegill	Little woodland remains—invaded by saltcedar; heavily used by wildlife; often near agricultural and urban areas

Table IV-9. Biological Resources

Lower Rio Grande Valley Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Mid-grass grasslands	Grama, three-awns, bluestems, curly mesquite, buffelgrass (introduced)	White-tailed deer, cotton rat, coyote, least shrew, Mexican ground squirrel, Eastern cottontail	Turkey, turkey vulture, bobwhite, scaled quail, mourning dove, great horned owl, meadowlark	Grasshoppers, spiders, Texas ratsnake, bullsnake	Little native grassland remains; converted to agriculture or rangeland uses; brush encroachment
Shrublands	Blackbush (acacia), mesquite, guajillo, granjeno, pricklypear, ceniza	Javelina, raccoon, white-tailed deer, Mexican spiney pocket mouse, striped skunk, jackrabbit, bats	Harris' hawk, scaled quail, white-winged dove, mourning dove, mockingbird, lesser nighthawk	Spotted whiptail, rose-bellied lizard, reticulate collared lizard, diamond-back rattlesnake, Texas tortoise	Many community types—largely fragmented, some threatened; nesting sites; used by migratory raptors; wildlife corridors; refugia from disturbed sites; native citrus thicket (Starr County)
Riparian woodlands	Mesquite, granjeno, cedar elm, hackberry, acacias, many fruiting species	Bobcat, ocelot, raccoon, bats, white-footed mouse	Ferruginous pygmy owl, orioles, mourning dove, chachalaca, green jay, kingfishers, warblers, boat-tailed grackle	Giant toad, Rio Grande leopard frog, Texas indigo snake, blue tilapia (introduced), killifish, catfish, green sunfish	Variety of wildlife foods; roosting and feeding areas; only occurrence of many species in the United States; unique biota in aquatic habitats
Seasonally wet basins and potholes	Granjeno, huisache, mesquite, pricklypear, Texas persimmon	Ocelot, jaguarundi	White-winged dove, white pelican, sandhill crane, black-bellied tree duck	Reticulate collared lizard, Texas tortoise	Wintering waterfowl habitat; habitat for many Texas rare and threatened species

Table IV-10. Biological Resources

Southeastern and Gulf Coastal Plain Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Alluvial and floodplain	Bald cypress, swamp gum, tupelo, swamp nettle	Otter, muskrat, raccoon	Red-eyed vireo, wood duck, pied-billed grebe	Many insects, eastern mud turtle, marbled salamander, ratsnake	Flood control; high density of nesting birds and amphibians
Marsh	Cordgrass, rushes, sedges, wild rice, some shrubs	Muskrat, marsh rice rat	Herons, egrets, ducks, common gallinule	Many insects and other invertebrates	Rookeries, fish nurseries
Pine forest	Species of pine, bay, blueberry, spicebush, hydrangea	Opossum, white-tailed deer, gray squirrel, short-tailed shrew, striped skunk, raccoon, big-eared bat, red fox	Long-eared owl, pine warbler, red-cockaded woodpecker	Tiger salamander, box turtle, coral snake, gopher tortoise	Cover and nesting sites; few old growth forests remain, most are intensively managed
Hardwood forest	Species of oak, gum, hickory, elderberry, greenbriar, ferns	Opossum, white-tailed deer, gray squirrel, short-tailed shrew, striped skunk, raccoon, big-eared bat, red fox	White-eyed vireo, blue jay, great-crested flycatcher, wood duck, red-tailed hawk, cardinal		
Grassland	Species of bluestem or panic grass	Ground squirrel, cottontail, plains woodrat	Common nighthawk, eastern meadowlark, bobwhite, killdeer, scissor-tailed flycatcher, mockingbird	Many insects	Undisturbed grasslands very rare

Table IV-11. Biological Resources

Mississippi Delta Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Salt marsh	Smooth cordgrass, wire grass, salt grass, black rush	Muskrat, otter, Norway rat	Marsh hawk, pintail, common loon, white pelican	Gulf salt marsh snake, gulf coast toad, diamondback terrapin	Feeding grounds for nesting and migrating birds; fish nursery
Fresh/brackish marsh	Maidencane, bulltongue, spike rush, alligator weed	Nutria, harvest mouse, rice rat	Scaup, teal, widgeon, gadwall, shoveler, mottled duck	Green treefrog, green anole, green frog	Feeding grounds for nesting and migrating birds
Bottomland hardwood	Water oak, overcup oak, bitter pecan, green ash, hawthorns	White-tailed deer, opossum, cottontail	Wood duck, red-shouldered hawk, turkey vulture	Three-toed box turtle, Mississippi ring-necked snake	Very high nesting density; habitat for large mammals
Swamp	Southern cypress, bald cypress, pond cypress, tupelo, black willow, swamp gum, cottonwood, button bush, swamp privet	Mink, bobcat, swamp rabbit, red bat	Great blue heron, great egret, anhinga, white ibis, Louisiana heron	Western cottonmouth, green anole, bronze frog, alligator	Rookeries for herons and egrets
Levee	Water oak, live oak, hackberry, American elm, honeylocust, hawthorn, marsh elder, groundsel bush	Rice rat, fulvous harvest mouse, least shrew		Bronze frog, ribbon snake, narrow-mouthed toad	Refuge during flooding; dry land corridors

Table IV-12. Biological Resources

Floridian Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Cypress swamps	Cypress, longleaf pine, slash pine, sabal palm	Cotton mouse, raccoon, shrews	Wood stork, herons, Everglades snail kite, turkey, warblers, bald eagle	Alligators, spiders, aquatic invertebrates	More rare or endangered species found in Cypress Swamps than any other Florida swamp; Florida panther habitat
Freshwater marshes	Pickerel weed, beakrush, maidencane, sawgrass	White-tailed deer, Florida water rat	Egrets, wood stork, ducks, Florida sandhill crane	Apple snail, amphipods (scuds), prawns, catfish, alligator	
Lakes, rivers, canals	Water hyacinth, cattails, eelgrass, pondweed	Raccoon, river otter, manatee	Kingfisher, herons, egrets, anhinga	Zooplankton, snails, clams, gar, catfish, suckers, silversides, minnows, sunfish	
Mangroves	Black mangrove, red mangrove, white mangrove, buttonwood	Raccoon, river otter, striped skunk, black bear, manatee	Brown pelican, spoonbill, wood stork, egrets, herons	Tarpon, mullet, snappers, shrimp, sea turtles, American crocodile	Nursery area for many commercial fish species
Salt marshes	Saltmarsh cordgrass, saltbush	Raccoon, marsh rabbit, cotton rats, bottlenose dolphin, rice rat	Cattle egret, swallows, marsh wren, seaside sparrow	Fiddler crab, shrimp, marsh crab, grasshoppers, plant hoppers, spiders, diamondback terrapin	Nursery area for many fish species
Pine flatwoods	Longleaf pine, slash pine, wax myrtle, saw palmetto	White-tailed deer, cotton mouse, cotton rat, gray fox, fox squirrel	Brown-headed nuthatch, pine warbler, great horned owl	Box turtle, black racer, pinewoods snake, anoles	
Scrub	Scrub oak, saw palmetto, myrtle oak, sand live oak, Florida rosemary	Flying squirrel, Florida mouse, cotton mouse, bobcat, gray fox, white-tailed deer	Florida scrub jay, bobwhite, common nighthawk, palm warbler, woodpeckers, screech owl	Florida scrub lizard, blue-tailed mole skink, gopher tortoise, sand skink	40 to 60% of the species are endemic

continued

Table IV-12, continued.

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Dry prairies	Switch grass, saw palmetto, wiregrass, gallberry	Cotton rat, nine-banded armadillo, Eastern harvest mouse, Eastern spotted skunk	Florida sandhill crane, common nighthawk, vultures, burrowing owls, crested caracara	Box turtle, black racer	
Rocklands	Gumbo limbo, pigeon plum, royal palm, live oak, strangler fig, wild coffee	Opossum, key deer, Florida mastiff bat, mangrove fox squirrel, white-tailed deer, raccoon	Northern cardinal, gray kingbird, Carolina wren, red-bellied woodpecker, pine warbler	Florida tree snail, Shaus swallow tail, anoles	Many tropical species only found in this habitat of the United States
Coastal dunes	Sea oats, sea lavender, saltbush	Marsh rabbit, rice rat, raccoon, cotton rat	Seaside sparrow, marsh wren, cattle egret, wading birds, fish crow	Sea turtles, diamondback terrapin, marsh crab, fiddler crab, grasshoppers, mollusks	

from adjacent agricultural and urban areas can enter the water conservation areas and contaminate water in the park with high concentrations of nutrients and pesticides.

Wildlife refuges and other land preserves are also areas of potential concern. These lands have been set aside to protect wildlife resources and often become islands surrounded by altered, intensely managed land. Generally comprised of many habitat types, they serve as refuges for less common species, provide wildlife corridors, and are important habitat for migratory birds. Nature Conservancy lands are protected because they contain unique features, often rare plants. Impacts to these habitats could affect many species.

The Laguna Atascosa National Wildlife Refuge in eastern Cameron County, Texas, on the gulf coastal plain, is the southernmost waterfowl refuge in the central flyway and is a primary overwintering area. It is the focal point for the recovery of the endangered northern aplomado falcon. FWS has issued a Biological Opinion that the use of chlorpyrifos, diazinon, and several other pesticides will jeopardize the continued existence of this species. As a result, it has recommended a 20-mile prohibited use zone around the refuge for these pesticides.

In addition to national- or state-protected areas, many areas of considerable importance are not afforded protection. An example of an unprotected area is the Colorado River in Yuma County, Arizona, which is known internationally as a prime bird-watching location. Many such locations occur throughout the program area.

4. Endangered and Threatened Species

Various species of fish, wildlife, and plants in the United States are so few in number that they are in danger of or threatened with extinction. The decline of most of these species is directly related to loss of habitat, but may also be the result of other factors including hunting, collecting, pollution, road kills, inter-species competition, or pesticides. Refer to appendix B for a listing of species in potential program areas of the nine program states. More than 200 federally listed species are found within the potential program area; they include plants, birds, fish, mammals, amphibians, reptiles, and at least one insect.

The Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. 1531 *et seq.*) mandates the protection of specifically listed endangered and threatened species and their critical habitats. It also requires Federal agencies to consult with FWS or the National Marine Fisheries Service to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or a species proposed for listing, or result in the destruction or adverse modification of its critical habitat or its proposed critical habitat.

Because of the number of threatened or endangered species potentially found within the areas affected by the Medfly eradication program, APHIS is involved in consultation with FWS. As part of this process, APHIS is preparing a Biological Assessment (incorporated by reference) for endangered and threatened species to determine if those species may be affected, either directly or indirectly by program operations (especially those activities related to pesticide

usage). The Biological Assessment groups species according to their habitats and their vulnerabilities to the program control methods. In its consultation with FWS, APHIS will establish which control methods may be used safely within the range and habitats of the endangered and threatened species. Additional protection measures may be required on a site-specific basis to ensure protection of those species.

E. Human Population

1. Demographics and Economics

The human population of the potential Medfly program area is extremely diverse (see table IV-13). The metropolitan areas are not homogeneous, but include human subpopulations with dissimilar compositions and social structures. That diversity is apparent, for example, when comparing the retirement communities of Florida, the Mexican-American communities of southern Texas, and the Asian-American communities of California. In addition, communities adjacent to metropolitan areas may include Native American tribes, suburban families, and farmers. Depending on the locale of future programs (hence, also community structure and activity), the exposure to Medfly control activities could vary considerably.

The economic levels vary widely across the potential Medfly program area, as well. Within the potential program areas, the lowest per capita incomes are in South Carolina, Alabama, and Mississippi. Although per capita income in metropolitan areas is higher than state-wide averages, every large city contains at least one area characterized by low-income residents; homeless people are more numerous in cities than in rural areas. The general health of a human population may be influenced by the population's economic status in that low-income people are often not able to afford nutritious food and good health care. Studies have demonstrated that liver disease and protein or thiamine deficiency can increase sensitivity to the effects of organophosphate pesticides (Casterline and Williams, 1969, and Cavagna et al., 1969). Thus, populations prone to these conditions may be at greater risk than the general population.

2. Special Considerations

The diverse demographic and economic characteristics of the potential Medfly program area indicate a need for special considerations in carrying out program activities. Notification of treatments, an important aspect of the program, can be complicated by language differences. The higher percentages of Hispanic or Asian Americans in cities such as Brownsville, Texas, and San Francisco, California, suggest that notification and other public communication may need to be in languages other than English.

Other human factors such as age, income, health, and culture may pose problems that will require special program considerations in order to minimize exposure to pesticides and resultant risk. Certain segments of the population (such as some of the elderly) will be more sensitive to the program activities than the majority of the population. Generally, metropolitan areas can be expected to include populations with a lower-than-average income and therefore with less health care, as well as homeless people. Nonurban populations with low

Table IV-13. Demographics of Potential Medfly Program Areas by Ecoregion

Ecoregion	State-wide Data				Metropolitan Area Data			
	State	% <5 years old	% >65 years old	% population in metropolitan areas	Major city or metro area(s)	% Hispanic	% Asian	Per[1] capita income
California Central Valley and Coastal	CA	8.6	10.6	95.7	Los Angeles-Anaheim-Riverside	32.9	9.2	18,938
					Oakland-San Jose[2]	15.5	14.8	22,438
					San Diego	20.4	7.9	17,576
					Sacramento	11.6	7.7	17,050
Southwestern Basin and Range	AZ	8.7	13.1	79.0	Phoenix	16.3	1.7	16,815
					Tucson	24.5	1.8	(14,995)
Lower Rio Grande Valley	TX	8.7	10.1	81.6	Brownsville-Harlingen	81.9	NDA[3]	(14,753)
Southeastern and Gulf Coastal Plain	SC	7.5	11.1	60.6	Charleston	NDA	NDA	(12,907)
	GA	7.9	10.1	65.0	Savannah	1.4	1.1	(15,280)
	AL	7.2	12.7	67.4	Mobile	NDA	NDA	(12,814)
	MS	7.7	12.4	30.1	Biloxi	NDA	NDA	(11,055)
	TX	8.7	10.1	81.6	Houston[4]	20.8	3.6	16,129
Mississippi Delta	LA	8.3	11.1	69.5	New Orleans	4.3	1.7	14,034
Floridian	FL	7.0	18.0	90.8	Miami-Ft. Lauderdale	33.3	0.7	18,322
					Tampa-St. Petersburg-Clearwater	6.7	1.5	16,409
					West Palm Beach	7.7	1.0	(16,515)
					Orlando	9.0	1.9	16,525

Source: U.S. Census Bureau, 1991.

[1]Data from 1988, in dollars. Numbers in parentheses are state-wide average (metropolitan area data not available).
[2]The Oakland-San Jose data also include the San Francisco metropolitan area, which is not in the potential program area.
[3]NDA = No Data Available.
[4]The Houston data also include the Galveston-Brazoria metropolitan area, which is not in the potential program area.

incomes might have more reliance on backyard fruits and vegetables as a food source. Cultural practices are another consideration if the program expands beyond metropolitan areas into Native American tribal lands (such as those surrounding San Diego, California, or Phoenix and Tucson, Arizona); program activities could affect a population of low-income sustenance farmers whose exposures might be greater because of their cultural practices (i.e., use of wild food).

F. Cultural Resources

Cultural resources (see table IV-14) are those resources that contribute to intellectual or aesthetic education. Cultural resources include historic sites, archaeological sites, Native American lands, religious sites, zoos, and arboreta. Many such sites exist within the Medfly program area, but those most likely to be affected by the Medfly program are located closest to urban areas where program activities will most likely occur. Cultural resources of special concern with respect to pest eradication programs include zoos, arboreta, and gardens because they contain nontarget species. The Floridian and California Central Valley and Coastal ecoregions have a large number of such sites in metropolitan areas.

Historic, archaeological, and Native American sites are protected by the National Historic Preservation Act, the Archaeological and Historical Preservation Act, and the Native American Graves Protection and Repatriation Act. Furthermore, many Native American reservations are considered as sovereign nations and, therefore, Medfly program activities would have to be coordinated with tribal councils or their equivalent.

G. Visual Resources

Visual resources (see table IV-15) consist of the landscapes and wildlife of a particular area. Natural visual resources are preserved in parks, forests, and wilderness areas. Most "scenic areas" are located some distance from urban centers; however, a few are near major cities in the potential Medfly program area, and could be affected by program activities. For example, traps placed in city parks could detract from the appearance of blossoms or foliage; equipment noise (trucks, airplanes, or helicopters) could intrude upon otherwise peaceful areas; and bird watchers or other visitors to natural areas could become upset if wildlife is affected by program activity or treatments.

Table IV-14. Representative Cultural Resources of Potential Medfly Program Areas by Ecoregion

Ecoregion	City and State	Representative Cultural Resources
California Central Valley and Coastal	Los Angeles-Anaheim-Riverside, CA	University of California Botanical Gardens, Los Angeles Zoo, Los Angeles Arboretum
	San Diego, CA	Quail Botanical Gardens, San Diego Zoo, Indian reservations
Southwestern Basin and Range	Phoenix, AZ	Westward Expansion historical sites, Indian reservations, Phoenix Zoo, Desert Botanical Garden
	Superior, AZ	Boyce Thompson Southwestern Arboretum
	Tucson, AZ	Spanish historical sites, Indian reservations, Desert Museum, Tucson Botanical Garden
Lower Rio Grande Valley	Brownsville, TX	Palo Alto National Historic Site
Southeastern and Gulf Coastal Plain	Charleston, SC	Magnolia Plantations, Cypress Gardens, Fort Sumter and other Civil War historical sites
	Savannah, GA	Colonial and Civil War historical sites
	Mobile, AL	Historical sites
	Biloxi, MS	Historical sites
	Houston, TX	Houston Zoological Gardens
Mississippi Delta	New Orleans, LA	French historical sites, Longue Vue House and Gardens, Louisiana Nature Center
Floridian	Miami-Ft. Lauderdale, FL	Metro Zoo, Orchid Jungle, Fairchild Tropical Garden, Seminole Indian village reconstruction
	Tampa-St. Petersburg, FL	Gamble Plantation, Yulee Sugar Mill, De Sota National Monument, Weedon Island Indian Mounds
	Orlando, FL	Fort Mellon, Mead Botanical Gardens

Table IV-15. Representative Visual Resources of Potential Medfly Program Areas by Ecoregion

Ecoregion	City and State	Representative Visual Resources[1]
California Central Valley and Coastal	Los Angeles-Anaheim-Riverside, CA	Cucamonga WA, San Gabriel WA
	San Diego, CA	Sweetwater Marsh NWR, Tijuana Slough NWR, Agua Tibia WA, Hauser WA, Pine Creek WA, San Mateo Canyon WA
Southwestern Basin and Range	Phoenix, AZ	Tonto NF
	Tucson, AZ	Saguaro WA, Coronado NF
Lower Rio Grande Valley	Brownsville, TX	Laguna Atascosa NWR
Southeastern and Gulf Coastal Plain	Charleston, SC	Cape Romain WA, Little Wambaw Swamp WA, Wambaw Creek WA
	Savannah, GA	Savannah NWR, Tybee NWR
	Mobile, AL	Bon Secour NWR
	Biloxi, MS	Deer Island
	Houston, TX	Sheldon WMA, Deer Park
Mississippi Delta	New Orleans, LA	Bayou Sauvage NWR, Bohemia State Park WMA
Floridian	Miami-Ft. Lauderdale, FL	Biscayne NP, Everglades NP and WA, Hugh Taylor Birch SP
	Tampa-St. Petersburg, FL	Weedon Island Preserve, Pinellas NWR, Caladesi Island SP
	Orlando, FL	Clear Lake, Lake Fairview, and other lakes

[1]Abbreviations: NF = National Forest, NP = National Park, NWR = National Wildlife Refuge, SP = State Park, WA = Wilderness Area, WMA = State Wildlife Management Area,

V. Environmental Consequences

A. Introduction

1. General Approach

The environmental consequences of the Medfly Cooperative Eradication Program result from or are related to program use of control methods (especially chemical control methods). This chapter focuses on the potential effects of the chemical control methods, and analyzes potential effects of chemical, nonchemical, and combined (may include both chemical and nonchemical components) methods on: the physical environment, human health and safety, biological resources, socioeconomics, and cultural and visual resources. Control methods were analyzed individually, but a section on cumulative effects contains information on potential effects of combined use of control methods. Refer also to chapter III, Alternatives, which compares the environmental consequences of the control methods within the context of alternatives.

2. Risk Assessment Methodology

The potential environmental consequences of the program have been analyzed qualitatively and quantitatively. Chemical control methods have been quantitatively assessed in a human health risk assessment (APHIS, 1992a) and a nontarget risk assessment (APHIS, 1992b), incorporated by reference. All control methods have been qualitatively assessed. Findings of these analyses are summarized within this chapter.

Classical risk assessment methodologies were used for both the human health and nontarget risk assessments (NRC, 1983). Each risk assessment had the following components: hazard assessment, exposure analysis (and dose-response assessment in human quantitative risk assessment), and risk assessment. The risk assessments are not predictive of what *will* occur, but rather what *can* occur in a program. The characterizations of risk that are determined assume the usage of control methods in specific ways and under certain circumstances. The assumptions involved reasonably foreseeable events and represented most possible exposures. Based on actual program operations and observed results, the results of these assessments must be considered conservative (tending to err on the side of higher rather than lower risk). The probability of the occurrence of the analyses' results cannot be determined. More detailed discussions of the methodology are in sections C and D, Human Health and Safety and Biological Resources, respectively. A review of the general approach follows.

a. Hazard Assessment

The hazard of each chemical to either humans or nontarget species was assessed by reviewing toxicity studies of species that best simulated the physiology and behavior of humans or other nontarget species under evaluation. Benchmark, or reference, toxicity values, used in the risk characterization, were identified from acute exposure studies for the nontarget species, and from acute, subchronic, and chronic exposure studies for humans.

Laboratory toxicity studies provide the basis for assessing the hazard of a chemical. These studies use a variety of concentrations and formulations. Very few, if any, toxicity studies have been conducted with the exact formulations used in APHIS Medfly programs. Hazard is therefore based on toxicity information available for each chemical because little data exist for toxicity of formulations.

b. Exposure Analysis

Specific scenarios based on the program concentrations, application methods, and exposed populations were developed to estimate exposures. To bracket the plausible ranges of exposure, certain conditions within each scenario were varied to account for routine, extreme, and (for humans) accidental exposures. After environmental concentrations were approximated through models or based on application rates, dose estimates for the individual human or nontarget species were calculated, considering oral, dermal, and inhalation routes of exposure.

Because this analysis considered (from a programmatic perspective) scenarios incorporating control methods that could be used across the broad program area, its routine scenarios are very conservative and include aspects of "worst-case analysis".

c. Risk Assessment

The quantitative risk assessments were based on methodologies and models detailed in sections C and D. Results of these analyses were compared with actual Medfly program data when these data were available. In the human health risk assessment, the calculated dose estimates were compared with the reference or benchmark toxicity values to express the level of concern for a particular exposure scenario or set of scenarios. The risk to an individual was determined by comparing the estimated dose and the reference or benchmark value. The magnitude of this ratio indicated the degree of risk. Risks to exposed populations of nontarget species were also estimated.

3. Computer Modeling

Computer models were used to estimate concentrations of pesticides in the environment and exposure to humans and nontarget species. The environmental fate models provided estimates of pesticide concentrations in air, soil, water, and on vegetation. A model developed by USDA's Forest Service, the Forest Service Cramer Barry Grim (FSCBG) model, was used to estimate malathion bait spray residues from drift on soil and vegetation outside the treatment area.

The Groundwater Loading Effects in Agricultural Management Systems (GLEAMS) model was used to estimate pesticide concentrations in soil, runoff water, and groundwater. Environmental Analysis and Documentation (EAD), Animal and Plant Health Inspection Service (APHIS), developed a surface water model (which is awaiting endorsement by other APHIS staffs) that was used to estimate malathion bait spray concentrations in aquatic systems. Estimated environmental concentrations from these models and other sources

were used in the exposure models. APHIS extrapolated from field measurements (Segawa et al., 1991), made adjustments to the application rate, and used the EPA pesticide nomograph (Urban and Cook, 1986) to estimate environmental concentrations in air and on vegetation.

Models and equations used in the human health risk assessment to estimate exposure and dose were based on methodologies developed and used by EPA to assess risk for chemicals under that agency's regulatory authority. EAD-APHIS developed two exposure models (awaiting endorsement by other APHIS staffs) for the nontarget risk assessment (APHIS, 1992b): one for terrestrial organisms and another for aquatic species. These models are discussed in section D (Biological Resources) of this chapter.

4. Information Data Gaps

The EPA has responsibility for pesticide registration and reregistration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA, section 3). A variety of data, including product and residue chemistry, environmental fate, and human, wildlife, and aquatic toxicity, are required for this process (see 40 CFR 158). EPA uses these data to make regulatory decisions concerning these pesticides.

Data gaps (deficiencies) have been identified by EPA either because registration requirements have changed or because previously submitted data have been ruled inadequate under current registration guidelines. Data gaps are listed in the EPA Registration Standards document for each pesticide. In some cases, data have been submitted since that document and are under review by EPA.

Data considered inadequate for registration purposes, or data not submitted to EPA but available from the literature or other sources, are often adequate to give indications of potential environmental effects. APHIS relied on EPA documents as well as other sources to evaluate potential environmental effects. Because all data needed for a complete evaluation were not available, APHIS used the available data and made extrapolations when necessary.

State and/or Federal supplementary or emergency registrations may be required to allow the use of some pesticides in the Medfly Cooperative Eradication Program. Under FIFRA, EPA grants emergency exemptions (section 18) or special local need uses (section 24(c)). These registrations will be needed for such uses as: aerial application of malathion bait sprays; certain regulatory uses of methyl bromide; and soil drench uses of diazinon, chlorpyrifos, and fenthion. Such registrations have been issued for earlier eradication efforts, but must be renewed periodically.

B. The Physical Environment

1. Chemical Control Methods

The chemicals proposed for use in the Medfly Cooperative Eradication Program have potential to affect soil (land), water, and air. These effects are minimized because of the low application rates used, the program standard operating procedures, and the program mitigative measures.

a. Bait Spray Applications

(1) Aerial Application of Malathion Bait

(a) Land Resources

The character of a soil is dependent not only upon its physical and chemical components, but also upon the presence of micro-organisms. The persistence of malathion bait in soil is related to a variety of factors, including the soil's microbial activity, pH (relative acidity), and organic matter content. Malathion's half-life in natural soil ranges from less than 1 day to 6 days, with 77% to 95% of the degradation occurring through microbial activity (Neary, 1985; Walker and Stojanovic, 1973). In laboratory studies, malathion toxicity to nitrifying bacteria was variable, with malathion causing slight toxicity to *Nitrobacter* sp., while causing complete inhibition of *Nitrosomonas* sp. (Bollen, 1961; Garretson and San Clemente, 1968). Malathion applied to soils did not affect the growth of several fungi or their ability to degrade other pesticides (Anderson, 1981). Malathion application to a forested watershed resulted in no observed effects on bacteria or fungi (Giles, 1970).

Inorganic degradation of malathion may be more important in soils that are relatively dry, alkaline, and low in organic content, such as those that predominate in the western program areas. Malathion is subject to hydrolysis under neutral and alkaline conditions, but is more stable under acidic conditions. It does not penetrate much beyond the soil surface and does not adsorb tightly to inorganic soil particles, although it binds tightly with organic matter (Jenkins et al., 1978). Adsorption to organic matter and rapid degradation make it unlikely that detectable quantities of malathion would leach to groundwater (LaFleur, 1979; HSDB, 1991). Because of agricultural and other uses, low-level background residues of malathion may occur in certain areas.

Malathion degradation products also have short half-lives. Malaoxon, the major malathion degradation product of concern in soil, has half-lives of 4 and 5 days in soils of pH 7.2 and 8.2, respectively (Pascal and Neville, 1976).

Environmental fate modeling using FSCBG predicts detectable malathion bait spray residues as far as 12 miles (mi) from the treatment block in high winds (10 miles per hour (mph)) and high release heights (500 feet (ft)). With lower wind speeds (5 mph) and release heights (200 ft), detectable residues (1 microgram per square foot (1 μg/ft2)) were predicted up to 3½ mi from the treatment block. Using GLEAMS, predicted concentrations of malathion in the upper centimeter of soil were highest immediately following application and ranged from a high of 0.34 micrograms per gram (μg/g) for the Lower Rio Grande Valley ecoregion to a low of 0.30 μg/g for the Southeastern and Gulf Coastal Plain. Following a rainstorm, the concentration of malathion would be expected to decrease in the upper 1 centimeter (cm) of soil, but increase slightly in the lower soil layers.

(b) Water Resources and Quality

Surface water contamination may occur from direct applications or runoff from treated plants and soils, particularly if a rainfall occurs soon after application. The half-life of malathion on foliage ranges from 1 to 6 days (Matsumara, 1985; Nigg et al., 1981; El-Refai and Hopkins, 1972). Degradation of malathion in water is mostly by photolysis (decomposition induced by light), microbial degradation under acidic conditions, and chemical transformations under alkaline conditions (Wolfe et al., 1977). The half-life of malathion in water with pH values from 5 to 8 ranges from 6 to 18 days (Paris and Lewis, 1973). Half-life in seawater at pH 8 was 2.6 days (Horvath, 1982). Malathion in chlorinated swimming pool water metabolizes readily to the more toxic metabolite malaoxon. The half-life of malaoxon in chlorinated swimming pool water has been determined to be 37 hours (CDFA, 1991). Monitoring of four aerial bait spray applications in the 1991 study showed no cumulative concentrations of malathion or malaoxon in fresh water or chlorinated swimming pools. Because of agricultural and other uses, low-level background residues of malathion may be present in water in certain areas.

Various sources have set different water quality criteria for malathion in freshwater and saltwater habitats. The EPA's water quality criterion for malathion is 0.1 μg/L (equivalent to 1 part per billion) for both freshwater and saltwater. This criterion is near or below the limit of detection for malathion using standard analytical techniques. By comparison, the California Department of Fish and Game (CDFG) water quality criteria for malathion (based on acute exposure) are 3.54 μg/L for freshwater and 10 μg/L for saltwater. The criteria for aquatic life are quite a bit lower than for human drinking water—the California Department of Health Services has established a Health Advisory Level of 160 μg/L for malathion in human drinking water.

Some directly sprayed water bodies within the treatment area could have malathion concentrations exceeding the EPA freshwater and saltwater criteria immediately following malathion aerial bait application. Environmental fate modeling predicted that in directly sprayed water bodies greater than 6 ft deep, malathion concentrations immediately after spraying were 11 μg/L or less. Shallow water bodies were estimated to have higher values (e.g., greater than 64 μg/L in water less than 1 ft deep). The modeling data are consistent with monitoring data from past programs. Malathion concentrations in aquatic habitats would decrease over time because of chemical and biological degradation and water flow into and out of the water body. Modeling predicts that malathion concentration decreases rapidly in flowing water and in water bodies with drainage outlets. For shallow water bodies in which CDFG water quality criteria may be exceeded for a short time, natural processes would make chronic exposures from program activities unlikely.

(c) Air Quality

Because of malathion's low volatility, high concentrations are unlikely to be detected in air. However, because of agricultural and other uses, low-level background residues of malathion may be present in the air in certain

locations. The atmospheric vapor phase half-life of malathion is 1.5 days (HSDB, 1990).

Criteria pollutants (pollutants for which maximum allowable emission levels and concentrations are enforced by state agencies) will be produced by internal combustion engine fuel consumption during control activities. Effects will be localized and minimal compared with vehicular activities in urban areas.

(2) Ground Application of Malathion Bait

(a) Land, Water, and Air Resources and Quality

The effects of malathion bait ground applications would not differ greatly from those of the malathion bait aerial applications described above. However, the greater precision of the ground-based techniques would lead to reduced exposure of soil, water, and air, with a subsequent reduction in residues. Aquatic habitats would have fewer impacts because they would not be sprayed directly. Modeling predicted runoff in only two ecoregions—the Mississippi Delta (5.4 µg/L) and Floridian (5.1 µg/L). Minor soil and vegetation disturbance could result from ground applications that involve use of truck-mounted equipment. Although targeting is more precise with ground applications, failure to detect or treat host material jeopardizes program efficacy and may result in subsequent need to resort to aerial applications, with increased potential for environmental consequences.

b. Soil Treatments

(1) Diazinon

(a) Land Resources

Diazinon's half-life ranges from 1.5 weeks in clay loam soils to 10 weeks in an organic soil (Getzin and Rosefield, 1966). The persistence of diazinon in soil increases with lower soil moisture content, increasing pH, decreasing temperature, and increasing organic matter content. Fifty percent of diazinon on a soil surface degraded after 24 hours of exposure to light (Burkhard and Guth, 1979). Microbial degradation of diazinon is a major source of its breakdown (Getzin, 1967; Getzin, 1968; Miles et al., 1979). Diazinon leaches very slowly in soil and is unlikely to reach groundwater (Sumner et al., 1987).

When applied as a soil drench, diazinon tends to remain in the upper 10 cm of the soil, with the majority of the chemical found in the upper 1 cm. In turf grass, 96% of the diazinon remained in the top 10 mm of turf; an increase in irrigation caused diazinon to break down more quickly, but did not increase leaching of the pesticide into the soil (Branham and Wehner, 1985). There is a possibility of plant uptake of diazinon from treated soil; however, breakdown in plant tissue is rapid (Lichtenstein et al., 1967). Environmental fate modeling (GLEAMS) predicts diazinon concentrations in the upper 1 cm of soil ranging from 11.81 µg/g in the Southeastern and Gulf Coastal Plain ecoregion to 24.85 µg/g in the Southwestern Basin and Range ecoregion.

(b) Water Resources and Quality

Surface water contamination from diazinon can occur following a rainstorm because of runoff from the treated area. Environmental fate modeling predicts little or no runoff following small storms, but more runoff following a large storm in two of the six ecoregions—the Mississippi Delta and the Floridian. Diazinon concentrations in runoff water from the soil drench area were predicted to be 25.1 μg/L in the Mississippi Delta and 0.4 μg/L in the Floridian ecoregions. Only a small volume of runoff water in a 9 mi^2 program area (0.14%) would come from areas treated with soil drenches. Concentrations of diazinon in surface waters would be several orders of magnitude lower than the concentration of diazinon in runoff water from the soil drench area.

(c) Air Quality

Diazinon volatilizes only slightly from soil (Burkhard and Guth, 1981). Air volatility of diazinon applied to soil in an orchard was 2.4% of applied active ingredient within the first 24 hours following application, 0.93% the second day, 0.11% the third day, 0.09% the fourth day, and was negligible thereafter (Goltfelty et al., 1990). Consequently, little or no diazinon would be expected to be detected in the air following a treatment. Because diazinon is applied as a soil drench, there will be little pollution produced by internal combustion engine fuel consumption during control activities.

(2) Chlorpyrifos

(a) Land Resources

The chlorpyrifos half-life in natural soils is about 30 days (EPA, OPP, 1992). When applied as a soil drench, chlorpyrifos tends to remain in the upper 1 cm of the soil profile. Chlorpyrifos degrades most rapidly in sandy loam soils, and least rapidly in organic soils. Studies show plants take up very little chlorpyrifos or its metabolite TCP (3,5,6-trichloro-2-pyridinol) following soil application (Smith et al., 1967). Chlorpyrifos tightly adsorbs to soil, and vertical movement is limited (Felsot and Dahm, 1979; Pike and Getzin, 1981). Residues on plants degrade at half-lives that range from 1 day to weeks and depend on application rates.

GLEAMS estimated chlorpyrifos concentrations in the upper 1 cm of the soil, ranging from 7.56 μg/g in the Floridian ecoregion to 10 μg/g in the Mississippi Delta ecoregion, for the 1 pound (lb) active ingredient per acre (a.i./acre) application rate. Chlorpyrifos concentrations predicted from the 4 lb a.i./acre application rate ranged from 30.22 μg/g in the Floridian ecoregion to 39.25 μg/g in the Lower Rio Grande Valley ecoregion. Following a rainstorm, the highest concentrations of chlorpyrifos were predicted to remain in the upper 1 cm of the soil.

(b) Water Resources and Quality

Surface water contamination from chlorpyrifos can occur following a rainstorm because of runoff from the treated area. The EPA has set water quality criteria

for aquatic life for chlorpyrifos in freshwater of 0.063 μg/L for acute exposure and 0.041 μg/L for chronic exposure. For saltwater these criteria are 0.011 μg/L for acute exposure and 0.0056 μg/L for chronic exposure. Environmental fate modeling predicts little or no runoff following small storms, but more runoff following a large storm in two of the six ecoregions—the Mississippi Delta and Floridian. Chlorpyrifos concentrations in runoff water from the soil drench area were predicted to be 825 μg/L at 4 lb/acre and 205 μg/L at 1 lb/acre in the Mississippi Delta ecoregion and 725 μg/L at 4 lb/acre and 189 μg/L at 1 lb/acre in the Floridian ecoregion. Only a small volume of runoff water in a 9 mi^2 program area (0.14%) would come from areas treated with soil drenches. Concentrations of chlorpyrifos in surface waters would be several orders of magnitude lower than the concentration of chlorpyrifos in runoff water from the soil drench area. In natural waters, chlorpyrifos adsorbs to sediments, reducing its bioavailability.

(c) Air Quality

The photolysis half-life of chlorpyrifos in air is 2.27 hours (Klisenko and Pis'mennaya, 1979, as cited in EPA, OPP, 1984). Approximately 0.27% of soil applied chlorpyrifos active ingredient will volatilize to air in the first 24 hours. As with the diazinon soil drench, there will be little production of pollution by internal combustion engine fuel consumption during control activities with chlorpyrifos.

(3) Fenthion

(a) Land Resources

Under aerobic soil conditions the half-life for fenthion is 24 hours (EPA, OPP, 1992). Fenthion residues in a column of loam soil leached with 570 mm (22.5 inches (in)) of rain in a 45-day period, but the majority of the residues remained in the upper 4 cm (approximately 2 in) of soil (EPA, 1988a). Leaching would not appear to be a major concern from soil applications for Medfly control. Some uptake of fenthion by plants (0.5% to 2% of applied active ingredient) has been observed following soil applications (Sirharan and Suess, 1978). Plant residues do not appear to be persistent except under silage conditions (Bowman et al., 1970).

There is only limited information on the environmental fate of fenthion. The soil half-life of 24 hours cited by EPA was determined in a soil with 75% moisture, which is three times normal moisture content under most conditions. Under less hydric conditions, the fenthion half-life in soils is likely to be longer than the reported value. Fenthion is somewhat persistent in pond water (half-life of 1.5 days) but the presence of sediment greatly reduces the chemical's bioavailability because fenthion will sorb to sediment.

Using GLEAMS, predicted fenthion concentrations in the upper 1 cm of soil ranged from 4.50 μg/g in the Southeastern and Gulf Coastal Plain ecoregion to 8.19 μg/g in the Mississippi Delta ecoregion. Following a rainstorm, fenthion

concentrations were predicted to be higher in the 1 to 10 cm soil layer than in the top centimeter.

(b) Water Resources and Quality

Surface water contamination from fenthion may occur after a rainstorm if there is runoff from the area drenched with fenthion. Environmental fate modeling predicts little or no runoff following small storms, but more runoff following a large storm in two of the six ecoregions—the Mississippi Delta and the Floridian. Fenthion concentrations in runoff water from the soil drench area were predicted to be 85 μg/L in the Mississippi Delta ecoregion and 24 μg/L in the Floridian ecoregion. Only a small volume of runoff water in a 9 mi2 program area (0.14%) would come from areas treated with soil drenches. Concentrations of fenthion in surface waters would be several orders of magnitude lower than the concentration of fenthion in runoff water from the soil drench area.

(c) Air Quality

No studies of the fate of fenthion in air are available. Based on chemical properties, approximately 0.1% of applied fenthion active ingredient would be expected to volatilize from soil in the first 24 hours. Air contamination from soil applications of fenthion for Medfly control would not appear to be a major concern. There will be little production of pollution by internal combustion engine fuel consumption during control activities with fenthion.

c. Fumigation

(1) Methyl Bromide

(a) Land Resources

After commodity fumigation, methyl bromide gas is vented into the atmosphere where it dissipates. Methyl bromide is not expected to reach soil; however, any methyl bromide that might reach soil breaks down to inorganic bromide residues and methanol with a half-life of 3 to 7 days (EPA, 1992).

(b) Water Resources and Quality

The solubility of methyl bromide in water is low. The half-life in water is 6.63 hours (Wegman et al., 1981). Preliminary EPA ground monitoring data show no detectable methyl bromide.

(c) Air Quality

Methyl bromide is highly volatile and disperses rapidly when released or vented from a fumigation chamber. However, methyl bromide is heavier than air and can accumulate briefly in low areas; treatment facilities therefore must be designed to avoid exposure to applicators or the general public in areas downwind from treatments. Long-term toxicity in air or half-life in air is not relevant because dispersal is so rapid.

Several environmental groups petitioned EPA to classify methyl bromide as a class I ozone depleting chemical. Since then, EPA ordered that U.S. companies phase out production of methyl bromide by the year 2000. The relative importance of methyl bromide in ozone depletion, however, is subject to fundamental uncertainties. Halogen gases (the class of compounds which includes bromine) have been implicated in ozone destruction in the stratosphere (mid atmosphere); ozone forms a layer around the earth which protects the surface from excessive ultraviolet exposure. Chlorine from sources such as chlorofluorocarbons (CFCs) is believed of primary importance in ozone depletion (Solomon et al., 1986).

CFCs have long half-lives in the atmosphere (80 to 100 years), but methyl bromide half-life in the stratosphere is 1.6 years or less (Mix, 1992). Aerosols from marine wave action have been assumed to account for the vast majority of atmospheric bromine (Sturges and Harrison, 1986). Estimates of the contribution of industrial and agricultural sources to atmospheric bromine levels range from less than 10% to 35% (Prathear et al., 1984; Wofsy et al., 1975). Reactions of combinations of bromine and chlorine with ozone have been modeled; however, bromine's actual contribution to ozone depletion is unclear (McElroy et al., 1986). Even if atmospheric bromine may contribute to ozone depletion, the extent of the contribution from agricultural methyl bromide uses is uncertain.

2. Nonchemical Control Methods

a. Sterile Insect Technique

The release of sterile insects is not expected to directly impact soil, water, and air resources because their relatively small biomass is not anticipated to contaminate those environmental media to any great extent. Burial or disposal of debris (paper bags and release cups) associated with sterile insect technique has little potential to result in soil disruption. Waste products associated with sterile insect production are disposed of in compliance with local laws and regulations.

Effects from sterile insect technique operations are not expected to greatly exceed the impacts associated with routine procedures that growers or homeowners use during planting, gardening, yard maintenance, or waste disposal operations. Only minor soil impacts will result from vehicular and foot traffic associated with monitoring of traps used with this technique.

b. Physical Control

Physical control methods (fruit stripping and host removal) may result in some soil disruption. Such activities also may increase soil erosion by removing protective plant material. In the southwest and western program areas where little natural vegetative cover exists, soil disturbances may be exacerbated by runoff during heavy winter rainstorms. Additionally, soil disturbance may also limit or disrupt populations of soil micro-organisms because of soil desiccation or erosion.

These potential effects from physical control methods are not expected to exceed the impacts upon soil, air, or water resources associated with routine procedures that growers or homeowners use during planting, gardening, or yard maintenance operations.

c. Cultural Control

Clean culture, or complete harvesting, of Medfly hosts would not result in effects on soil, water, or air resources or quality. Burial of host material would be in existing approved landfills and would not be expected to result in any measurable increased impact to those facilities. Most other cultural practices, including crop rotations or trap crops, are not applicable to Medfly control programs.

d. Biological Control

Although holding promise for the future, biocontrol of Medfly has not yet been proven logistically or technologically feasible on a potentially large scale. Therefore, information on biological control agents' potential effects upon land, water, or air resources and quality is unavailable at this time.

e. Biotechnological Control

Also holding promise for the future, no biotechnological control methods for Medfly are currently adaptable for the program. Therefore, information on biotechnological control methods' potential effects upon land, water, or air resources and quality is unavailable at this time.

f. Male Annihilation

Use of sticky panels to attract male Medflies is not expected to directly affect soil, water, or air resources. Depending on frequency of monitoring or replacement, slight soil impacts could result from vehicular and foot traffic.

3. Combined Control Methods

The following combined control methods merge more than one type of control in an organized strategy (refer to Alternatives, chapter III). They may or may not include chemical methods, depending upon the alternative chosen. For example, combined controls for Medfly eradication (including chemicals) could employ chemical pesticides; combined controls for Medfly eradication (no chemicals) would include no pesticides.

a. Regulatory Control

Most regulatory activities associated with Medfly eradication or control programs would not be expected to result in any increase in environmental impacts to soil, water, or air resources or quality, over those already resulting from normal commercial farming activities. The impacts of chemical components of regulatory control (methyl bromide fumigation, soil treatments, and malathion bait sprays) are the same as those previously discussed. Use of cold

treatment, vapor heat treatment, and hot water treatment would not be expected to have major environmental impact.

b. Integrated Pest Management

Integrated pest management involves the use of the control methods previously discussed, either singly or in combination, to suppress (manage) or to eradicate Medfly populations. The effects expected for soil, water, or air resources or quality are the same as those which have already been identified for the individual control methods that would be employed. Aside from the additive effects expected from the use of several control methods, no additional effects are anticipated.

C. Human Health and Safety

Risks to human health and safety associated with chemical, nonchemical, and combined Medfly control methods were analyzed. The primary concern for impacts to human health in the Medfly program relates to the potential effects of the chemical insecticides.

The subsection on chemical control methods is divided according to the type of control methods (e.g., bait spray or soil drenches) and then subdivided according to the specific pesticide(s) used for that control method. The discussion for each pesticide summarizes the hazard of the chemical, the potential public and worker exposure to that chemical, and the quantitative and qualitative risks associated with the estimated doses to humans. The sections on nonchemical control methods and combined control methods qualitatively discuss the potential effects on human health and safety of implementing the individual methods.

This section also discusses the potential effects of the program on hypersensitive individuals, those people who may be extremely sensitive to even very small amounts of pesticides. There is also a discussion of the effect that noise from the program has on humans, and how people may be affected psychologically by program operations.

Models and equations used in the human health risk assessment to estimate exposure and dose to humans were based on methodologies developed and used by EPA in risk assessments for chemicals under its regulatory control. Refer to the Human Health Risk Assessment for APHIS Fruit Fly Eradication Programs (incorporated by reference) (APHIS, 1992a) for greater detail on those methodologies. Potential exposure concentrations in or on various media, i.e., water, soil, and vegetation, were determined from application rates and the results of the environmental fate models. The risk assessment considered oral, dermal, and inhalation exposures, both single and multiple-route of exposure, in some cases. Absorption through the skin was estimated based on methodologies recommended by EPA (EPA, OHEA, 1992). Routine, extreme, and accidental scenarios were modeled for the general public in the treatment area and for workers in the program. Average population values of human characteristics that greatly influence exposure and dose, e.g., body weight, consumption

patterns, and activity patterns, were taken from Exposure Factors Handbook (EPA, OHEA, 1990). In some cases, estimates of doses to workers were based on modifications to literature-based experimentally determined exposures or doses of other pesticides to workers performing similar tasks.

Quantitative toxicological assessments involve the derivation of dose levels associated with a regulatory risk goal. These derivations are termed regulatory reference values (RRVs) in this document. These values are an estimate (with inherent uncertainty) of the dose to which an individual can be exposed over a specified period of time without an appreciable risk of adverse affects. RRVs are conceptually similar to a number of other toxicological assessments conducted by various governmental agencies, and were derived using methods similar to those used by EPA for deriving RfDs (reference doses) and RfCs (reference concentrations) and those used by ATSDR (Agency for Toxic Substances and Disease Registry) for deriving MRLs (minimum risk levels). An attempt was made to determine the most sensitive toxicological endpoint or effect, and one that increased in severity as dose increased. An "experimental threshold" dose was selected, which is the highest dose in a series of doses causing the effect that is below any dose associated with any adverse effect.

To derive the RRV, the identified experimental threshold was divided by an uncertainty factor intended to account for differences between the experimental exposure and the conditions for which the RRV was being derived. Tenfold uncertainty factors were generally used to account for:

1. variation in sensitivity among members of the human population,
2. uncertainty in extrapolating animal data to humans,
3. uncertainty in extrapolating from less than chronic No Observed Adverse Effect Levels (NOAELs) to chronic NOAELs (where NOAEL is the highest dose level of a chemical that, in a given toxicity test, causes no observable adverse effect in the test animals), and
4. uncertainty in extrapolating from Lowest Observed Adverse Effect Levels (LOAELs) to NOAELs (where LOAEL is the lowest dose level of a chemical that, in a given toxicity test, causes an observable adverse effect in the test animals).

The tenfold uncertainty factor to account for variability among the human population was omitted when deriving the RRV for workers, under the assumption that the special disease conditions or impaired physical states that it was intended to account for among sensitive groups of the general population usually are not found among the workforce. Acute, subchronic, and chronic RRVs have been derived for various exposure durations.

Quantitative risk characterization was accomplished by comparing the exposure assessment with the toxicological assessment to determine a hazard quotient (HQ). When appropriate, all relevant routes of exposure were considered to derive a composite HQ. An HQ that approached or exceeded 1 (that is, when the exposure dose approached or exceeded the RRV) was generally associated with a cause for concern for adverse effect in the exposed population. In most cases, an HQ greater than 1 constituted unacceptable risk. However, in some

cases, the uncertainties associated with the exposure and toxicological assessments resulted in a lack of confidence in the HQ. Therefore, a qualitative judgment was required to characterize the risk involved when the dose was above the RRV.

1. Chemical Control Methods

a. Bait Spray Applications

Malathion bait spray may be applied aerially from airplanes or helicopters, or to foliage from the ground using either backpack or truck-mounted sprayers. Risks to the public from either aerial or ground treatments with malathion bait would be similar since the application rate per acre treated is the same for both application methods. Public exposure to malathion will be less from ground applications than from aerial applications because nearly all of the pesticide hits the intended target (trees and foliage) and little ends up in the surrounding area. Exposures, and therefore risk, to workers from the different application methods are different. Therefore, separate exposure assessments and risk assessments were performed for different worker scenarios.

(1) Malathion Aerial Application

(a) Hazard Assessment

Malathion is an organophosphate insecticide whose mode of toxic action is primarily through acetylcholinesterase (AChE) inhibition (Smith, 1987; Klaassen et al., 1986). At low doses, the symptoms include slight AChE inhibition in humans as well as localized effects such as nausea, sweating, dizziness, and muscular weakness. The effects of higher doses of malathion may include irregular heartbeat, elevated blood pressure, cramps, convulsions, and respiratory failure. However, AChE inhibition can be measured in blood at levels much below that which causes symptoms; therefore, adverse health effects do not necessarily result from all levels of AChE inhibition.

Generally, toxicity data is unavailable for individual formulations of pesticides. The malathion bait formulation is no exception. In these cases, regulatory values established by EPA and other agencies have been based on the toxicity characteristics of the technical grade (or pure) chemical. It is this information that has been reviewed and incorporated into this hazard assessment of malathion. The acute oral toxicity of malathion is slight to humans (U.S. DHHS, NIOSH, OSHA, 1978). The acute toxicity of malathion by the dermal route is minimal and is considered one of the least dermally toxic of the organophosphorus insecticides (EPA, OPP, 1989b). Malathion is a very slight dermal irritant and a slight eye irritant (EPA, OPP, 1989b). Studies of acute delayed neurotoxicity have been negative (EPA, OPP, 1989b).

Testing also indicates relatively low chronic toxicity. The human RfD was established at 0.02 milligrams per kilogram per day (mg/kg/day) based upon no AChE inhibition at a higher concentration (0.23 mg/kg/day) and applying an uncertainty factor of 10 (Moeller and Rider, 1962; EPA, OPP, 1989b). Malathion may be immunosuppressive and immunopathologic *in vitro* at high

concentrations (Desi et al., 1978; Thomas and House, 1989). Reproductive and teratology studies are outstanding data requirements of EPA for reregistration of malathion (EPA, OPTS, 1990), but adequate data are available for determining a teratogenic NOEL based upon a study of rabbits (25 mg/kg/day) (EPA, OPP, 1989b).

Carcinogenicity, mutagenicity, and genotoxicity tests have included many results that are clear and some that are equivocal. The tests for carcinogenicity provide either negative or equivocal data. The EPA has classified malathion as a class D chemical relative to potential carcinogenicity (EPA, OPP, 1990). This indicates that malathion could not be classified definitively without additional tests to replace those tests containing equivocal results. Malathion does not induce gene mutations in bacteria, but can cause chromosomal damage to mammalian cells (WHO, IARC, 1983). Malathion may be an alkylating agent of DNA nucleic acids (Griffin and Hill, 1978).

There are data gaps according to EPA for reproductive and developmental toxicity studies in mammals, acute delayed neurotoxicity in birds, and carcinogenicity tests of malathion and malaoxon, an AChE-inhibiting metabolite of malathion (EPA, OPTS, 1988a). However, adequate data are available to determine potential effects by quantitative and qualitative analyses for given environmental exposures.

(b) Exposure Analysis

Calculated doses of malathion from aerial application were determined for routine, extreme, and accident scenarios. Calculated doses of malathion determined for single route exposure scenarios to the general public range from 4.3×10^{-6} mg/kg/day for a routine exposure scenario (a child incidentally ingesting a very small amount of soil from an area that had been aerially sprayed) to 9.3×10^{-2} mg/kg/day for an extreme exposure scenario (an adult contacting sprayed vegetation before the malathion bait spray dried). Calculations of groundwater concentrations were determined by using the leaching output for pervious ground surfaces (soil) from the GLEAMS model assuming a ½-inch rainfall 24 hours after application (extreme), 48 hours after application (routine Florida), or 72 hours after application (routine California). Calculations for runoff water assumed rainfall at the same intervals, but used runoff calculations from impervious surfaces.

Other exposure scenarios included an individual eating vegetation from a backyard garden in a treated residential area and both dermal uptake and inadvertent drinking of directly sprayed chlorinated swimming pool water contaminated with malathion and malaoxon. Other dermal exposures included contact with sprayed vegetation and direct exposure to the spray. Inhalation exposures were determined for breathing indoor and outdoor air within the treatment area. Based on available monitoring data, potential inhalation doses of malathion were not considered to be a substantial concern. A calculated inhalation exposure to malaoxon for the general public was 0.016 $\mu g/m^3$ for a routine exposure scenario of an adult breathing indoor air for 16 hours and outdoor air for 8 hours from a treated area.

Doses to workers involved in aerial application operations were calculated based upon routine, extreme, and accident scenarios. Calculated doses of malathion determined for single route exposure scenarios to workers range from 3.0×10^{-4} mg/kg/day for a routine exposure scenario for a mixer/loader to 8.4×10^{-2} mg/kg/day for an extreme exposure scenario for the ground personnel, including kytoon handlers, flaggers, and quality control crew. Exposures were also determined for pilots of the applicator airplanes. Data from pesticide studies on a surrogate chemical, 2,4-D, were the basis for calculations of exposures to pilots (Nash et al., 1982) and mixer/loaders (Lavy et al., 1987). For ground personnel, estimates of exposure were made from previously monitored air levels and nominal application rates. The calculated doses for ground personnel ranged from 6.2×10^{-2} to 8.4×10^{-2} mg/kg/day for various scenarios that involve spills of malathion concentrate onto the skin.

(c) Quantitative Risk Assessment

The regulatory reference values (RRVs) for malathion used in this risk assessment were 0.02 mg/kg/day for the public and 0.2 mg/kg/day for workers, both derived from a NOEL for AChE inhibition (0.23 mg/kg/day).

The HQs determined for the general public indicate that there are no unacceptable risks of adverse effects from malathion exposure from drinking or contact with groundwater or runoff water, or from swimming in or inadvertently drinking swimming pool water (which also takes into consideration exposure to malaoxon). Inhalation of malathion was not a major route of concern, even when the risk assessment was modified with reasonably conservative assumptions to consider levels of malaoxon in air. The scenarios that considered soil consumption by children, even in cases of pica behavior, resulted in HQs of less than 1, and therefore no unacceptable risks. Pica may be defined as a pathological behavior characterized by the persistent eating of nonnutritive, generally nonfood, substance. There was some cause for concern with HQs greater than 1 from the scenarios representing an adult contacting contaminated vegetation or consuming contaminated vegetation, although both were extreme exposure scenarios that would be preventable by providing warnings. The routine exposure scenario of an adult consuming contaminated vegetation resulted in an HQ of less than 1.

Based on the HQs determined for the exposure scenarios for aerial application workers, there were no unacceptable risks for pilots, mixer/loaders, or the ground personnel. The scenario for the ground personnel incorporated exaggerated exposure conditions which encompass accidental exposures.

In addition, program operational procedures prevent unacceptable risks from exposures to pesticides. Workers are routinely tested for inhibition of AChE, which, at low levels of inhibition, indicates exposure to organophosphates but does not necessarily produce adverse health effects. When AChE inhibition is demonstrated, that worker should be prevented from continuing in any job that would further his exposure to the organophosphate pesticides. Operational procedures also dictate that program personnel be fully instructed in emergency procedures, and that appropriate equipment for washing is available, in the

event of accidental pesticide exposure. Under the circumstances where a large quantity of pesticide is spilled on a worker, personnel have the appropriate equipment necessary to rinse the chemical off rapidly so that dermal absorption is minimized. By preventing additional exposures after a worker is showing AChE inhibition and by decreasing absorption of pesticide through the skin, risks of systemic effects from exposures are minimized.

(d) Qualitative Risk Assessment

Neurotoxicity

Neurotoxicity is any toxic effect on any aspect of the central or peripheral nervous system. Such changes can be expressed as functional changes (such as behavioral or neurological abnormalities) or as neurochemical, biochemical, physiological, or morphological alterations. Malathion poses a neurotoxic risk only as a consequence of inhibition of AChE. It does not pose any risk of delayed neurotoxic symptoms or structural neuropathy. The quantitative risk assessment of AChE inhibition analyzes the only neurotoxic risks. As a result, no unacceptable neurotoxic risks are anticipated other than those already presented in the quantitative risk assessment.

Immunotoxicity

Immunotoxicity is any toxic effect mediated by the immune system, such as dermal sensitivity, or any toxic effect that impairs the functioning of the immune system. Malathion has only been shown to be immunosuppressive and immunopathologic to mammalian cells at high concentrations *in vitro*. Malathion has not been shown to alter immune functions in mammals *in vivo*. Based upon the limited evidence of immunotoxic effects, malathion should not pose an unacceptable risk of adverse human immune system effects.

Genotoxicity and Mutagenicity

Genotoxicity is a specific adverse effect on the genome (the complement of genes contained in the haploid set of chromosomes) of living cells that, upon the duplication of the affected cells, can be expressed as a mutagenic or a carcinogenic event because of specific alteration of the molecular structure of the genome. It results from a reaction with deoxyribonucleic acid (DNA) that can be measured either biochemically or, in short-term tests, with end points that reflect on DNA damage. DNA contains the genetic material of a cell.

Mutagenicity is an adverse effect that produces a heritable change in the genetic information stored in the DNA of living cells. There is some evidence that malathion may pose a genetic hazard at high concentrations based upon some *in vivo* and *in vitro* cytogenetic studies where chromosomal aberrations and reactivity with DNA had a weak association to exposure, but the majority of studies do not support a finding of any genetic hazard from malathion exposure (WHO, IARC, 1983; Griffin and Hill, 1978). The potential risk of clastogenic injury increases if the high doses of malathion formulation contain sufficient impurities. The technical grade malathion is of high purity, and exposures resulting from applications are relatively low compared to the thresholds

for genotoxicity. Based upon this, there should be no unacceptable risks of genotoxicity or mutagenicity from program applications of malathion.

Carcinogenicity

Carcinogenicity is an adverse effect that causes the conversion of normal cells to neoplastic cells and the further development of neoplastic cells into a tumor. A neoplasm is an altered, relatively autonomous growth of tissue composed of abnormal cells, the growth of which is more rapid than that of other tissues and is not coordinated with the growth of other tissues. Considerable evidence exists to conclude that malathion is not carcinogenic in laboratory animals and that neither malathion nor malaoxon are likely to present any risk of cancer to humans. EPA has placed malathion in class D relative to potential carcinogenicity (EPA, OPP, 1990). This indicates that malathion cannot be classified definitively without additional tests that meet the study criteria acceptable to EPA. Two rat studies of malathion have been accepted by EPA as evidence of negative findings. Based upon this evidence, there are no unacceptable risks of carcinogenicity anticipated for this program and no quantitative cancer risk analysis is justified.

Reproductive and Developmental Toxicity

Reproductive toxicity is any adverse effect that produces changes in the capacity to produce viable offspring, for example, by affecting the reproductive organ systems or hormonal functioning. Developmental toxicity is any adverse effect in the parent or the offspring that produces changes in fetal or neonatal growth and development, including physiological, morphological, biochemical, or behavioral changes.

The lowest NOEL determined for these effects from malathion exposure was a developmental NOEL of 25 mg/kg/day in rabbits (EPA, OPP, 1989b). This exposure level is considerably higher than the NOEL for AChE inhibition (0.23 mg/kg/day) analyzed in the quantitative risk assessment, so these effects would not be anticipated unless other effects were first noted. There are no unacceptable risks of reproductive or developmental toxicity to workers or to the public from any scenario.

Impurities in Formulations Applied

The main impurities of concern in malathion are isomalathion (95 times as toxic as malathion) and malaoxon (68 times as toxic as malathion) (CDHS, 1991; Aldridge et al., 1979; Ryan and Fukuto, 1985; Fukuto, 1983). Neither chemical is persistent and should not constitute any problem to this program as long as proper storage and handling procedures are followed.

Synergistic Effects

Although the toxicity of malathion may be potentiated by some other organophosphates and carbamates (Knaak and O'Brien, 1960; Cohen and Murphy, 1970), it is impossible to predict multiple exposures and synergism from applications not related to this program. Dichlorvos was not found to be synergistic with malathion, but only additive (Cohen and Ehrich, 1976). Diazinon is

synergistic to malathion (Keplinger and Deichmann, 1967), and although they may be used within the same treatment program, simultaneous application of the two pesticides usually does not occur. Even though it still may be possible for an individual to be exposed to malathion and diazinon within a critical exposure window, the implications of such an exposure are not clear. There is some potential for synergistic effects resulting from the combination of malathion and inadvertent simultaneous pesticide application by the public; however, public notification about program treatments helps to minimize this risk.

(2) Ground Application of Malathion Bait

(a) Hazard Assessment

The hazard assessment for malathion bait spray is presented in the previous section on malathion aerial application. The formulation, including the lure, is the same with both application methods.

(b) Exposure Analysis

Calculated doses of malathion from ground application were determined for routine, extreme, and accident scenarios. Malathion exposures to the public from ground applications are generally the same, but may be somewhat less than from aerial applications because the directed spray hits the trees and foliage, and not the surrounding area. Calculated doses to the public from ground application of malathion are, therefore, considered the same as from aerial application and are presented in that section.

Exposure to malaoxon is not expected to result from either swimming in a pool or ingesting pool water following ground application. The precise targeting of trees and vegetation from ground application should prevent the deposit of the pesticide into pools. Malaoxon is the malathion oxidation product which results most readily from contact with chemicals in pool water. However, inhalation exposures to malaoxon by individuals in the treatment area are considered the same as those from aerial application, and are presented in that section.

Exposures to workers involved in ground applications are different from those to workers involved in aerial applications. Doses to ground workers were calculated based upon routine and extreme scenarios. Calculated doses of malathion determined for single route exposure scenarios to workers range from 3.0×10^{-4} mg/kg/day for a routine exposure scenario for mixer/loaders to 0.153 mg/kg/day for an extreme exposure scenario for the backpack applicators. Exposures were also determined for hydraulic rig applicators. Data from pesticide studies on a surrogate chemical, 2,4-D, were the basis for calculations of exposures to backpack and hydraulic rig applicators and mixer/loaders (Lavy et al., 1987). The calculated doses for ground personnel determined for the assessment of aerial applicators, and which include scenarios for accidental exposure, ranged from 6.2×10^{-2} to 8.4×10^{-2} mg/kg/day for various scenarios that involved spills of malathion concentrate onto the skin.

(c) Quantitative Risk Assessment

Because the exposures to the public from malathion bait spray are similar from either aerial application or ground application, the risks to the public are also similar and are presented in the previous section on malathion aerial application.

Based on the HQs determined for the exposure scenarios for ground workers, there were no unacceptable risks for backpack applicators, mixer/loaders, or hydraulic rig applicators. Accidental exposure conditions were evaluated in the section on malathion aerial application, and indicated that there were no unacceptable risks.

(d) Qualitative Risk Assessment

Risk of humans developing neurotoxic effects, immunotoxic effects, genetic or mutagenic effects, oncogenic effects, or reproductive or developmental effects from exposures to malathion bait spray are similar for both aerial and ground applications. These risks are discussed in the section on aerial application of malathion bait.

b. Soil Treatments

The human health and safety risks to the public and workers from the application of diazinon, chlorpyrifos, or fenthion as soil treatments are considered in this section. Because chlorpyrifos is being considered for use at two rates of application, a risk assessment was performed for the potential exposures that could occur from each application rate.

(1) Diazinon

(a) Hazard Assessment

Diazinon is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition (Smith, 1987; Klaassen et al., 1986). At low doses, the signs and symptoms of AChE inhibition in humans include localized effects (such as blurred vision and bronchial constriction) and systemic effects (such as nausea, sweating, dizziness, and muscular weakness). The effects of higher doses may include irregular heartbeat, elevated blood pressure, cramps, convulsions, and respiratory failure.

The acute oral toxicity of diazinon is moderate to humans (Gosselin et al., 1984). The acute toxicity of diazinon by the dermal route is low to moderate (Gaines, 1960; EPA, OPP, 1988a). Technical diazinon is not a dermal irritant, but other formulations may be slightly irritating to skin (EPA, ODW, 1988). Diazinon has been shown to be a dermal sensitizer (EPA, OPP, 1988a). Diazinon is considered to be a mild eye irritant with corneal opacity and slight conjunctival redness from treatment (Agrochemicals Handbook, 1990; EPA, OPP, 1988a). Studies of delayed neurotoxicity have been negative or equivocal (EPA, OPP, 1988a).

Chronic testing indicates moderate to high toxicity in animals. The lowest NOEL based upon plasma AChE inhibition is 0.006 mg/kg/day in dogs (Williams et al., 1959). A NOEL at 0.009 mg/kg/day was determined from a 92-day study of rats (Davies and Holub, 1980). Based upon the NOEL for AChE inhibition in this study, a human oral provisional acceptable daily intake (PADI) of 0.00009 mg/kg/day was established by EPA (EPA, OPTS, 1990a).

Several tests for carcinogenicity, mutagenicity, and genotoxicity have been completed. The tests for carcinogenicity provide good evidence that diazinon is not carcinogenic (NCI, 1979). Diazinon does not induce gene mutations in bacteria with or without metabolic activation (EPA, ECAO, 1984; EPA, OPTS, 1988). Studies of unscheduled DNA synthesis and sister chromatid exchange are also predominantly negative (Simmons et al., 1979; Sasaki, 1982). Positive results were found for chromosomal aberrations in human lymphocytes (Lopez et al., 1986).

Several reproductive and developmental studies have been conducted with diazinon. The lowest NOEL values for various outcomes were 7 mg/kg/day for reproductive effects, 20 mg/kg/day for maternal toxicity, 100 mg/kg/day for fetotoxicity, and 100 mg/kg/day for teratogenicity (EPA, ODW, 1988; EPA, OPP, 1988a).

Chronic feeding studies and rat reproduction studies are listed by EPA as FIFRA data gaps (EPA, OPTS, 1989), but adequate data are available to determine potential effects by quantitative and qualitative analyses for given environmental exposures.

(b) Exposure Analysis

Calculated doses of diazinon determined for exposure scenarios to the general public range from 6.3×10^{-5} mg/kg/day for an exposure scenario of a child drinking from a contaminated groundwater source to 2.1×10^{-2} mg/kg/day for an extreme exposure scenario of a 10 kg child with pica ingesting soil immediately after application of the soil drench.

Doses to workers were calculated based upon routine, extreme, and accident scenarios for hand applicators and mixer/loaders. Calculated doses of diazinon determined for workers range from 4.8×10^{-4} mg/kg/day for a routine exposure scenario for mixer/loaders to 2.8×10^{-2} mg/kg/day for an extreme exposure scenario for a hand applicator.

(c) Quantitative Risk Assessment

The RRVs used in this risk assessment were 0.003 mg/kg/day for acute and subchronic effects, and 0.0005 mg/kg/day for chronic effects for the general public, and 0.03 mg/kg/day for acute and subchronic effects and 0.005 mg/kg/day for chronic effects for workers. The RRVs were derived from health advisories recommended by the EPA Office of Drinking Water (EPA, ODW, 1988). Since the health advisories were based on a study in which the high dose was associated only with cholinesterase inhibition, and no frank effects were observed, HQs of less than or equal to 2.5 did not cause substantial concern. However,

HQs greater than 10 may be associated with severe clinical effects. The inhalation RRV, based on the TLV-TWA (threshold limit value-time weighted average) recommended by ACGIH (1992), was 0.1 mg/m^3. This TLV notes that skin absorption may be an important route of exposure.

The HQs determined for routine exposure scenarios of diazinon to the general public indicate no unacceptable risk from groundwater or soil consumption. The scenario in which a 10 kg (approximately 22 lb) toddler is exposed to diazinon dermally from 1 hour of playing in turf 6 hours after application results in an HQ of 1.7. However, because the HQ was less than 2.5, this exposure did not cause concern. The HQs determined for extreme exposure scenarios of diazinon to the general public indicate a cause for concern for a child consuming soil immediately after a soil drench application. However, the public will be adequately cautioned to prevent children or toddlers from entering the drenched area until after the spray has dried. Theoretical exposures of the public to drinking from groundwater sources or breathing air near areas where the soil has been drenched were determined to be toxicologically insubstantial relative to other routes of exposure.

The HQs determined for workers were calculated based upon routine, extreme, and accident scenarios. The HQs calculated from the routine and extreme scenarios for the soil drench applicators and the mixer/loaders indicated that there were no unacceptable risks for these workers. An HQ of 2 was determined from an accident scenario in which a worker spilled diazinon concentrate on a lower leg and washed it off 2 hours later. Again, for diazinon, HQs of less than or equal to 2.5 did not raise concern.

(d) Qualitative Risk Assessment

Neurotoxicity

Diazinon has been shown to cause neurological damage in offspring of mice treated during gestation (Spyker and Avery, 1977) and to nerve cells *in vitro* (Obersteiner and Sharma, 1976). Studies of delayed neurotoxicity of diazinon to chickens were either negative or equivocal (EPA, OPP, 1988a). Doses that might cause neurotoxicity in humans, other than that resulting from AChE inhibition, would not be expected to occur in this program. In addition, AChE inhibition would likely be noted (during routine testing) from exposures to lower doses, which would alert the worker to prevent continued exposure before higher doses could potentially produce lasting neurological effects.

Immunotoxicity

Diazinon has been shown to be a dermal sensitizer, but data demonstrating other immune reactions were not located. Therefore, there is insufficient evidence to clearly determine the risk of immune system effects in individuals exposed to diazinon at the levels anticipated in this program. However, based upon the limited evidence, program use of diazinon should not pose an unacceptable risk of adverse immune system effects.

Genotoxicity and Mutagenicity

Studies for mutagenicity of diazinon have generally produced negative results (EPA, ECAO, 1984; EPA, OPTS, 1988a; Simmons et al., 1979; Abe and Sasaki, 1982), although chromosomal aberrations were detected in studies with human lymphocytes (Lopez et al., 1986). However, it is unlikely that the exposures that could occur from program use of diazinon would pose an unacceptable risk of genetic toxicity to the public or workers.

Carcinogenicity

From chronic bioassays in rats and mice, the National Cancer Institute (1979) has concluded that diazinon was not carcinogenic under the conditions of the tests. Therefore, it is unlikely that the potential diazinon exposures evaluated in the scenarios from this program would present an unacceptable risk of carcinogenicity.

Reproductive and Developmental Toxicity

The reproductive and developmental NOEL of 7 mg/kg/day (EPA, OPP, 1988a) is several orders of magnitude greater than the NOEL for AChE inhibition that served as the basis for the derivation of the RRV. Under these circumstances, parental cholinesterase inhibition and systemic effects, which both have lower NOELs, would be evident before there were unacceptable risks of developmental effects in humans.

Impurities in Formulations Applied

The main impurity and degradation product of concern in diazinon formulations is sulfotepp. This compound is relatively stable in the environment, can accumulate, and is much more toxic than diazinon to mammals and aquatic organisms (Meier et al., 1979). This compound has only been a problem when improper storage and handling resulted in transformation of the formulated product to higher levels of sulfotepp and monothiono-TEPP (Soliman et al., 1982).

Synergistic Effects

Although the toxicity of diazinon may be potentiated by some other organophosphates and carbamates (Keplinger and Deichmann, 1967; Seume and O'Brien, 1960), it is impossible to predict multiple exposures and synergism from applications not related to this program. The toxicity of diazinon and malathion appears to be synergistic (Keplinger and Deichmann, 1967), and although they may be used within the same treatment program, simultaneous application of the two pesticides usually does not occur. Even though it still may be possible for an individual to be exposed to diazinon and malathion within a critical exposure window, the implications of such an exposure are not clear. There is some potential for synergistic effects resulting from the combination of diazinon and inadvertent simultaneous pesticide application by the public; however, public notification about program treatments helps to minimize this risk.

(2) Chlorpyrifos

(a) Hazard Assessment

Chlorpyrifos is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition (Smith, 1987; Klaassen et al., 1986). At low doses, the signs and symptoms of AChE inhibition in humans include localized effects (such as blurred vision and bronchial constriction) and systemic effects (such as nausea, sweating, dizziness, and muscular weakness). The effects of higher doses may include irregular heartbeat, elevated blood pressure, cramps, convulsions, and respiratory failure.

The acute oral toxicity of chlorpyrifos is moderate to severe in humans (Gosselin et al., 1984). Chlorpyrifos is considered moderately toxic (EPA Toxicity Category II) to other mammals through oral and dermal routes of exposure. Acute inhalation toxicity is considered a data gap by EPA (EPA, OPP, 1984a), although studies have indicated that the acute inhalation toxicity of chlorpyrifos is moderate (EPA, OPP, 1988a). Chlorpyrifos is a slight to moderate dermal irritant, depending on the formulation, and is considered a slight to moderate eye irritant, showing conjunctival irritation that clears after 48 hours (EPA, OPP, 1984a; 1989d).

Reports of chronic and subchronic toxicity tests, as measured by plasma and red blood cell cholinesterase (ChE) inhibition, indicate that the toxicity to humans is relatively low. A human oral RfD of 0.003 mg/kg/day was established by EPA based on no cholinesterase inhibition at 0.03 mg/kg/day, and an uncertainty factor of 10 to account for the range of human sensitivity for cholinesterase inhibition (EPA, ORD, 1988). Cholinesterase inhibition in red blood cells from dermal exposure was reported to occur at higher doses (EPA, OPP, 1989c). Subchronic inhalation exposure at the highest attainable vapor concentration (20.6 ppm) by rats over 90 days produced no ChE inhibition. The major metabolite of chlorpyrifos, TCP, is structurally dissimilar and is not thought to be a cholinesterase inhibitor (EPA, OPP, 1989d).

Chlorpyrifos has not shown delayed neurotoxicity at the doses tested (EPA, OPP, 1984a). There was no observable evidence of dermal sensitization, and data on immunotoxicity indicate that chlorpyrifos does not induce delayed dermal hypersensitivity, as tested in guinea pigs. The data on carcinogenicity suggest that chlorpyrifos is noncarcinogenic. Most studies on mutagenicity in mammals indicate that chlorpyrifos is nonmutagenic, although some results suggest that chlorpyrifos may cause chromosomal aberrations and may be directly toxic to DNA (LAI, 1992a).

Reproductive toxicity studies of chlorpyrifos have shown no effects at doses up to 1 mg/kg/day. EPA has determined that chlorpyrifos does not cause developmental toxicity at doses up to 15 mg/kg/day, and that it is not teratogenic at levels up to 10 mg/kg/day. Maternal effects (cholinesterase inhibition) were seen at 0.3 mg/kg/day, with a NOEL at 0.1 mg/kg/day (EPA, OPP, 1989d).

EPA lists a chronic feeding-oncogenicity study with rats as a FIFRA data gap, but adequate data are available to determine potential effects by quantitative and qualitative analyses for given environmental exposures.

(b) Exposure Analysis

Separate exposure analyses were performed for high and low application rates of chlorpyrifos soil drench treatments. Calculated doses of chlorpyrifos at the low application rate determined for exposure scenarios to the general public range from 4.9×10^{-9} mg/kg/day for a routine exposure scenario of a 10 kg child drinking from a groundwater source in an area in California that was treated 72 hours before a rainstorm to 6.6×10^{-3} mg/kg/day for an extreme exposure scenario of a 10 kg child consuming soil from a drenched area immediately after application.

Doses to workers were calculated based upon routine, extreme, and accident scenarios for hand applicators and mixer/loaders. Calculated doses of chlorpyrifos from the low application rate determined for workers range from 7.7×10^{-4} mg/kg/day for a routine exposure scenario for mixer/loaders to 1.2×10^{-2} mg/kg/day for an extreme exposure scenario for a hand applicator. The calculated dose from an accident scenario in which a worker spills chlorpyrifos concentrate (or mixture which evaporates to pure chlorpyrifos) on an uncovered lower leg and does not wash for 2 hours is 8.7×10^{-4} mg/kg/day.

Calculated doses of chlorpyrifos at the high application rate determined for exposure scenarios to the general public range from 8.7×10^{-9} mg/kg/day for a routine exposure scenario of a 10 kg child drinking from a groundwater source in an area in California that was treated 72 hours before a rainstorm to 2.8×10^{-2} mg/kg/day for an extreme exposure scenario of a 10 kg child with pica ingesting soil from a drenched area immediately after application.

Calculated doses of chlorpyrifos from the high application rate determined for workers range from 3.1×10^{-3} mg/kg/day for a routine exposure scenario for mixer/loaders to 4.8×10^{-2} mg/kg/day for an extreme exposure scenario for a hand applicator. The calculated dose from the accident scenario is the same as for chlorpyrifos at the low application rate since the exposure was assumed to be to the concentrate.

(c) Quantitative Risk Assessment

The oral RRVs used in this risk assessment were 0.003 mg/kg/day for acute, subchronic, and chronic effects for the general public and 0.03 mg/kg/day for acute, subchronic, and chronic effects for workers. The RRVs were derived from a NOEL for AChE inhibition (0.03 mg/kg/day) which was the basis for the derivation of the verified RfD from EPA. The inhalation RRV, based on the TLV-TWA recommended by ACGIH (1992), was 0.2 mg/m^3. For chlorpyrifos, exposures above the RRV, that is, an HQ above 1, may be cause for concern, and exposures that result in an HQ above 3 may be associated with clinical effects.

The HQs determined for routine exposure scenarios of chlorpyrifos at the low application rate to the general public indicated that there were no unacceptable risks of adverse effects. The extreme exposure scenario presented some cause for concern for a 10 kg child ingesting drenched soil immediately after application (HQ = 2.2). However, residents are adequately cautioned to prevent children from entering the treated area until after the spray has dried.

The HQs for toxicity to workers were calculated based upon routine, extreme, and accident scenarios. In the routine and extreme scenarios at the low application rate, the HQs were less than 1, indicating that there were no unacceptable risks to soil drench applicators or mixer/loaders. An HQ of 0.3 was determined from the accident scenario in which a worker spilled chlorpyrifos concentrate on his/her a lower leg and washed it off 2 hours later. Therefore, there was no cause for concern for an accidental exposure of this type.

In a routine exposure scenario of chlorpyrifos at the high application rate in which a 10 kg toddler plays for 1 hour on turf 6 hours after the pesticide is applied, the resulting HQ was 2.1. Another scenario that presented a cause for concern was the extreme exposure scenario in which a 10 kg child with pica ingests drenched soil immediately after chlorpyrifos application (HQ = 9.3). These exposures present a reason for concern in one case and a possibility of causing clinical effects in the other case. Even though residents are adequately cautioned to prevent children from entering the treated area until after the spray has dried, the possibility that these exposures could occur (which would result in HQs greater than 1) indicates that chlorpyrifos should be used with caution in areas where children may play.

The HQs determined for workers were calculated based upon routine, extreme, and accident scenarios. The HQs calculated from the routine scenarios for the soil drench applicators and the mixer/loaders indicated that there were no unacceptable risks for these workers. However, the HQ of 1.6 for an extreme exposure scenario for the drench applicators might be cause for concern. Although the HQ is only slightly above 1, the dose/severity slope for humans was interpreted to be atypical based on the available data. Under these circumstances, any exposure level that exceeds the RRV might raise concerns, and exposure levels of 1 mg/kg/day (an HQ of about 3) may be associated with clinical effects. An HQ determined from the accident scenario was the same as for the low application rate (HQ = 0.3) because the exposure was assumed to be to the concentrate.

(d) Qualitative Risk Assessment

Neurotoxicity

Data on neurotoxicity of chlorpyrifos to mammals, other than that which occurs due to AChE inhibition, were not located. There was no evidence of delayed neurotoxicity in an acute study in hens (EPA, OPP, 1989d). It is not expected that the doses that could occur from exposures to either the low or high application rates of chlorpyrifos during program use would present an unacceptable risk of neurotoxicity.

Immunotoxicity

The only data available on immunotoxicity indicate that chlorpyrifos did not induce delayed dermal hypersensitivity in guinea pigs. Chlorpyrifos drench applications are not expected to pose an unacceptable risk of adverse immune system effects under the conditions of use in this program.

Genotoxicity and Mutagenicity

Most studies on mutagenicity in mammals indicate that chlorpyrifos is nonmutagenic. Some results suggest that chlorpyrifos may cause chromosomal aberrations and may be directly toxic to DNA, although these results were not seen in mammalian test systems (LAI, 1992a). The exposures to chlorpyrifos that are possible from program use are not likely to pose an unacceptable risk of genetic toxicity.

Carcinogenicity

The EPA (EPA, OPP, 1989d) reported that mouse and rat chronic toxicity/oncogenicity studies did not reveal any evidence that chlorpyrifos is carcinogenic. Therefore, it is not expected that chlorpyrifos exposures from this program, at either the low or high application rates, would present an unacceptable risk of carcinogenicity.

Reproductive and Developmental Toxicity

Based on a three-generation rat study, chlorpyrifos has shown no effects at doses up to 1 mg/kg/day. EPA has determined that chlorpyrifos does not cause developmental toxicity at doses up to 15 mg/kg/day, and that it is not teratogenic at levels up to 10 mg/kg/day. A reproductive and developmental NOEL is 2.5 mg/kg/day, based on postimplantation loss (EPA, OPP, 1989d). This NOEL is higher than the NOEL used for derivation of the RRV. Therefore, reproductive and developmental effects would not be anticipated without first causing other effects. Unacceptable risks of reproductive and developmental effects to the public are not expected from program use of chlorpyrifos at either the low or high application rates.

Impurities in Formulations Applied

TCP (also known as 3,5,6-TCP and 3,5,6-trichloropyridinol, or TC-pyridinol) is the major metabolite of chlorpyrifos. TCP is structurally dissimilar to chlorpyrifos and is not considered to be an inhibitor of cholinesterase (EPA, OPP, 1989d).

Synergistic Effects

The toxicity of chlorpyrifos has been shown to be potentiated by another organophosphate (phosfolan). However, the insecticide phosfolan has been discontinued (Farm Chemicals Handbook, 1991) so that simultaneous exposure of the two pesticides should not occur. The addition of ascorbic acid (vitamin C) to the diet of rats was reported to enhance the acute toxicity of chlorpyrifos and increase serum phosphatase activity (U.S. DHHS, NIOSH, 1987).

(3) Fenthion

(a) Hazard Assessment

Fenthion is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition (Smith, 1987; Klaassen et al., 1986). At low doses, the signs and symptoms of AChE inhibition in humans include localized effects (such as blurred vision and bronchial constriction) and systemic effects (such as nausea, sweating, dizziness, and muscular weakness). The effects of higher doses may include irregular heartbeat, elevated blood pressure, cramps, convulsions, and respiratory failure. Fenthion has also been shown in animal studies to produce ocular effects similar to those observed in humans exposed to organophosphate pesticides (EPA, OPP, 1988b).

The acute oral toxicity of fenthion is moderate to severe in humans (Gosselin et al., 1984). Acute dermal and inhalation toxicities are considered to be moderate, although in animal studies, whole-body exposure to fenthion was eight times more toxic than snout-only exposure (Iwasaki et al., 1988). Fenthion is minimally irritating to the skin and eyes (EPA, OPP, 1988c).

Chronic and subchronic toxicity testing and accidental and intentional human exposure reports of fenthion indicate very high toxicity to humans. EPA has recommended an RfD of 0.00005 mg/kg/day based on a LEL of 0.05 mg/kg/day from a 1-year dog feeding study and an uncertainty factor of 1,000. The World Health Organization has established an acceptable daily intake of 0.001 mg/kg/day (EPA, OPP, 1990a).

Fenthion has five cholinesterase-inhibiting metabolites: fenthion sulfoxide, fenthion sulfone, fenthion oxygen analog, fenthion oxygen analog sulfoxide, and fenthion oxygen analog sulfone (EPA, OPP, 1988c).

Two studies using rat and chick cell cultures determined that fenthion can affect dopamine levels and nerve cell growth, indicating that there is a possibility of fenthion being neurotoxic. Reduced antibody titers in chickens that were fed fenthion suggest that it may be immunosuppressive. Fenthion was not a dermal sensitizer when tested in guinea pigs (EPA, OPP, 1985). Fenthion at doses up to 25 mg/kg has been found to be nonmutagenic in male mice (EPA, OPP, 1988c).

Reproductive and developmental toxicities have been investigated using rabbits exposed to fenthion during gestation. The maternal toxicity NOEL is 6 mg/kg/day, the fetotoxic NOEL is 2 mg/kg/day and the teratogenic NOEL is 18 mg/kg/day. Other reproductive effects were studied in rats that showed no adverse effects in three generations exposed to doses as high as 75 ppm in their feed (EPA, OPP, 1988b).

Fenthion is classified by EPA in category D for carcinogenicity, indicating that insufficient evidence is available to draw a conclusion regarding its potential to produce cancer in laboratory animals or humans. Therefore, carcinogenicity studies of fenthion have been listed by EPA as data required for reregistration (EPA, OPP, 1988b). Nonetheless, adequate data are available to determine

potential effects by quantitative and qualitative analyses for given environmental exposures.

(b) Exposure Analysis

Calculated doses of fenthion determined for exposure scenarios to the general public range from 1.2×10^{-6} mg/kg/day for a routine exposure scenario of a 10 kg child drinking from a groundwater source in an area in California after a rainstorm 72 hours after a treatment to 2.2×10^{-2} mg/kg/day for an extreme exposure scenario of a 10 kg child with pica ingesting soil from a drenched area immediately after application.

Doses to workers were calculated based upon routine, extreme, and accident scenarios for hand applicators and mixer/loaders. Calculated doses of fenthion determined for workers ranged from 9.0×10^{-4} mg/kg/day for a routine exposure scenario for mixer/loaders to 4.0×10^{-2} for an extreme exposure scenario for a hand applicator. The calculated dose from an accident scenario in which a worker spills fenthion concentrate or mixture on an uncovered lower leg and does not wash for 2 hours is 7.6×10^{-3} mg/kg/day.

(c) Quantitative Risk Assessment

The oral RRVs used in this risk assessment were 0.00005 mg/kg/day for acute, subchronic, and chronic effects for the general public and 0.0005 mg/kg/day for acute, subchronic, and chronic effects for workers. The oral RRVs were based on an RfD recommended by the EPA Office of Pesticide Programs, derived from an AEL (adverse effect level) of 0.05 mg/kg/day for spleen enlargement in a 1-year dog study. The inhalation RRV was 0.2 mg/m^3, which was adopted from the TLV-TWA established by ACGIH (1992).

The HQs determined for the extreme and the routine exposure scenarios of fenthion to the general public indicated that the projected exposures in some scenarios presented substantial risk of adverse effects. The HQs exceeded 1 in routine scenarios depicting a 10 kg toddler incidentally ingesting a very small amount of soil from a drenched area immediately after fenthion application (HQ = 11), and a 10 kg toddler dermally exposed to fenthion for 1 hour by playing on the ground 6 hours after drench application (HQ = 102). The extreme exposure scenarios obviously resulted in much higher HQs. The HQs determined for both routine and extreme scenarios of a 10 kg child drinking from a groundwater source receiving runoff from fenthion soil drench application indicated that ground water contamination was toxicologically insubstantial relative to other routes of exposure.

The HQs for toxicity to workers were calculated based upon routine, extreme, and accident scenarios. The HQs determined for mixer/loaders in both the extreme and routine exposure scenarios presented some risk of adverse effects (HQs = 3.3 and 1.7, respectively). For the hand applicators, the calculated HQs indicated that both the extreme and the routine exposure scenarios presented substantial risk of adverse effects (HQs = 80 and 44, respectively). An HQ of 0.15 was determined from the accident scenario in which a worker spilled fenthion concentrate on a lower leg and washed it off 2 hours later. Therefore,

there was no cause for concern for an accidental exposure of this type. Although it may appear illogical that a routine exposure would be more of a health risk than an accidental exposure, the rationale is that under accidental exposure conditions, the pesticide would likely be rinsed off much more rapidly, diminishing the time for dermal absorption.

(d) Qualitative Risk Assessment

Neurotoxicity

In vitro studies have suggested that fenthion may be a neurotoxic agent, although the only clear data in animals and humans show cholinergic symptoms resulting from AChE inhibition after exposure to high doses. Epidemiological surveys of workers exposed to fenthion indicate that symptoms disappear within 4 hours of exposure; there was no evidence of peripheral neuropathy (Wolfe et al., 1974; Beat and Morgan, 1977). Scenarios in which a child consumed soil or contacted sprayed ground, predict exposures that pose a risk of adverse systemic effects. Therefore, exposures at this and higher levels may put the public or workers at risk of temporary nervous system effects.

Immunotoxicity

On the basis of negative responses in dermal sensitization studies in guinea pigs (EPA, OPP, 1985), and the lack of evidence for humoral and cell-mediated immunotoxic potential (Singh et al., 1988; Rodgers et al., 1986), fenthion is unlikely to present an unacceptable immunological risk to humans.

Genotoxicity and Mutagenicity

Fenthion was found to be nonmutagenic in male mice up to 25 mg/kg, with a systemic NOEL for mutagenicity at 10 mg/kg. Tests for gene mutation, structural chromosomal aberrations, and other genotoxic effects were negative (EPA, OPP, 1988b). This evidence suggests that fenthion does not pose a risk of causing heritable genetic mutations or somatic genotoxicity to humans exposed in the Medfly Program.

Carcinogenicity

EPA has classified fenthion as an "inadequate evidence, Group D" carcinogen based on review of two oncogenicity studies in the rat and one in the mouse (EPA, OPP, 1988b). These studies did not provide sufficient evidence to draw a conclusion about carcinogenicity in humans.

Reproductive and Developmental Toxicity

Fenthion was found to produce reproductive and developmental effects in a rabbit teratology study (EPA, OPP, 1988b). In this study, the maternal toxicity NOEL was 6 mg/kg/day, the fetotoxic NOEL was 2 mg/kg/day, and the teratogenic NOEL was greater than or equal to 18 mg/kg/day. The EPA concluded that fenthion does not induce developmental effects in rabbits. These exposure levels are several orders of magnitude greater than the NOEL (0.05 mg/kg/day) used to derive the RfD of 0.00005 mg/kg/day for fenthion recommended by

EPA. Therefore, reproductive and developmental effects would be secondary to systemic effects that would be observed at a much lower dose. Under these circumstances, unacceptable risks of reproductive and developmental effects to the public and most workers would not be expected from program use of fenthion. However, the extreme exposure scenario posed some risk of toxicity to the fetus of a pregnant soil drench applicator.

Impurities in Formulations Applied

Technical fenthion was found to have 23 impurities, eight of which have been identified as phosphorus-containing. Some of these have been tentatively identified as the sulfoxide and sulfone of fenthion, and the sulfoxide and sulfone of fenoxon. Technical fenthion was reported to be only slightly more toxic than the purified fenthion, based on rat LD_{50} studies. The symptoms observed were characteristic of AChE inhibition. The difference in toxicity may be attributed to the small amount of fenoxon in the technical material (Toia et al., 1980).

Synergistic Effects

Several organophosphate pesticides, including malathion and dioxathion (Delnav), were reported to cause potentiation of fenthion acute toxicity (EPA, OPP, 1985). Although malathion and fenthion may be used during the same treatment program, simultaneous application of the two pesticides usually does not occur. Even though it still may be possible for an individual to be exposed to fenthion and malathion within a critical exposure window, the implications of such an exposure are not clear. There is some potential for synergistic effects resulting from the combination of fenthion and inadvertent simultaneous pesticide application by the public; however, public notification about program treatments helps to minimize this risk. Dioxathion was discontinued by the manufacturer in 1989 (Farm Chemicals Handbook, 1991) so that simultaneous exposure of dioxathion with fenthion will not occur.

c. Fumigation

(1) Methyl Bromide

(a) Hazard Assessment

Methyl bromide is an organic compound which contains the inorganic element bromine. Inorganic bromine occurs naturally in soils and food, and is also found in humans in varying concentrations. A blood-bromine level of 50 ppm is considered normal (Hayes and Lawes, 1991). Levels above this may be indications of methyl bromide exposure. Levels up to 1,500 ppm were achieved when inorganic bromide drugs were prescribed and no apparent ill effects were noted (Gay, 1962; as cited in Hayes and Laws, 1991).

The mode of toxic action of methyl bromide is not well understood. The central nervous system is the primary target of toxic effects. There is evidence that the observed toxicity is caused by methyl bromide itself and not its metabolites or by-products (Honma et al., 1985).

At low concentrations human symptoms of exposure appear slowly and include: dizziness, blurring vision, sluggishness, tiredness, staggering, slurred speech, nausea, vomiting, lack of appetite, and loss of muscle coordination. High concentrations of methyl bromide can cause more rapid onset of symptoms, including convulsions, and can result in lung damage. Chronic overexposure causes peripheral nerve damage. Prolonged skin and eye contact can cause burns (Great Lakes Chemical Corporation, 1989; Hayes and Laws, 1991).

The acute toxicity of methyl bromide has been determined by the oral and inhalation routes for several species. Acute lethal doses to humans have been determined to be 1,583 ppm in air for a 10- to 20-hour exposure and 7,890 ppm for a 1.5-hour exposure (EPA, ORD, 1986). The acute oral median lethal dose to rats was determined to be 214 mg/kg (Sax and Lewis, 1989). The acute inhalation median lethal doses to animals range from 1.2 ppm for 5 hours to guinea pigs (Sayers et al., 1929; as cited in Alexeeff and Kilgore, 1983) to 2,700 ppm for 30 minutes in rats (EPA, ORD, 1986).

The subchronic and chronic toxicity studies of methyl bromide have also analyzed the oral and inhalation routes of exposure. The lowest NOEL determined for oral exposure was 0.4 mg/kg/day in a subchronic gavage study of rats based upon hyperplasia of the epithelium of the forestomach at the LEL of 2 mg/kg/day (Danse et al., 1984). The lowest NOEL determined for inhalation exposure was 20 ppm in a chronic study of mice (EPA, OPP, 1990a). Decreased liver weights were noted at the LEL of 40 ppm in this study. No information was located about immunotoxic effects from methyl bromide exposure. Several studies found neurotoxic effects in rodents when exposed to methyl bromide over extended periods of time.

Unequivocal evidence of carcinogenicity has not been shown in any studies of methyl bromide. A study in rats receiving methyl bromide by gavage for 90 days found well-differentiated squamous cell carcinoma in 13 animals (Danse et al., 1984), but a panel of the National Toxicology Program reviewed this study and determined that there was no evidence of carcinogenicity. Following procedures similar to Danse et al., another study found that stomach lesions regressed in rats which had stopped receiving treatment (Boorman et al., 1986). Oncogenicity was negative for rats exposed by inhalation for 29 months to concentrations as high as 90 ppm (EPA, OPP, 1990a).

Most researchers have found that the mutagenic potential of methyl bromide is low (Hayes and Laws, 1991). Methyl bromide can cause chromosomal aberrations in human lymphocytes *in vitro*, and in rat bone marrow *in vivo* (Garry et al., 1990; Fujie et al., 1990). Methyl bromide has been shown to cause sister chromatid exchange in human blood and human lymphocyte cultures (Tucker et al., 1985; Garry et al., 1990).

No adverse reproductive effects, including fetotoxicity and teratoxicity, were seen in rats and rabbits exposed to 20 and 70 ppm methyl bromide gas for 6 to 7 hours/day during gestation (Hardin et al., 1981). Ninety-six percent of the rabbits died at the higher concentration, but there was no indication of

maternal toxicity in the rabbits at 20 ppm (NOEL) and in the rats at both concentrations.

Based upon reduced maternal weight observed in pregnant rats at an inhalation LEL of 90 ppm, the maternal NOEL was determined to be 30 ppm (EPA, OPP, 1990a). Reduced rates of pregnancy set the reproductive LEL at 30 ppm. Based upon reduced pup weights and survival at 30 ppm (fetotoxic LEL), a fetotoxic NOEL was set at 3 ppm (EPA, OPP, 1990). Hurtt and Working (1988) found only temporary effects on plasma testosterone levels in male rats exposed to 200 ppm for 6 hours/day for 5 days. No lasting effects on sperm quality or spermatogenesis were noted.

FIFRA data gaps exist for mutagenicity, rabbit teratology, subchronic inhalation in the rat and rabbit, and chronic feeding studies in the rat and dog (EPA, ORD, 1986), but adequate data are available to determine potential effects by quantitative and qualitative analyses for given environmental exposures.

(b) Exposure Analysis

The lack of both monitoring data on levels of exposure associated with fumigations using methyl bromide and air dispersion models designed to estimate levels of a gas in the area surrounding the fumigation apparatus have made it impossible to quantify the exposures that may occur during program use of methyl bromide. However, details regarding operating procedures and typical circumstances surrounding fumigations were considered in determining the potential for exposure to the public and to workers. The safety procedures required of the personnel conducting the fumigation of regulated commodities are stringently enforced to prevent unacceptable risk to humans from exposure under routine conditions. Workers are required to wear protective clothing and maintain a 30-ft (10-m) restricted area around the fumigation chamber where access is limited to individuals with self-contained breathing apparatus. Although some fumigations are performed near the source of the commodity, fumigation operations generally are carried out in rural, or otherwise, remote locations, so that public exposures are very unlikely.

The possibility exists for accidental release of methyl bromide through a tear in a tarp, or a leak in a hose or canister. In the event of an accident, workers, and in extremely rare circumstances, the public, may be exposed to levels of methyl bromide above that recommended to protect human health.

(c) Qualitative Risk Assessment

An RRV of 0.48 mg/m^3 for chronic exposure of the general population was adopted from the RfC established by EPA (EPA, ECAO, 1992). The RfC was based on a 29-month inhalation study in rats in which the lowest exposure concentration caused degenerative lesions in the nasal cavity. Because this study was adjusted for a 6-hour exposure, and because the exposures projected in this risk assessment are likely to be much less than 6 hours, the chronic RRV was adjusted by a factor of 4 ($24 \div 6$) to yield an intermittent RRV of 1.92 mg/m^3 for general population exposure. The ACGIH (1992) recommends a TLV-TWA of 19 mg/m^3 with a notation that unprotected skin could exacerbate exposure.

This value was adopted as the inhalation RRV for workers. This recommendation has been in effect since 1986. In the documentation for the TLV, ACGIH (1986) notes that the toxicological data are not adequate for recommendation of a short-term exposure limit (STEL). Following the general guidelines in ACGIH (1992), exposures of up to 3 times the TLV-TWA for no more than a total of 30 minutes are considered acceptable. Exposures greater than or equal to 5 times the TLV-TWA for any duration are considered unacceptable.

Because monitoring data and air dispersion models were determined to be inappropriate for characterizing exposures to either the general public or workers, a qualitative assessment of risk was performed. Fumigations with methyl bromide are conducted in a manner that prevents unacceptable risk to people. For fumigations conducted in locations without a wall to prevent access to the chamber, there is a 30-ft (10-m) area around the fumigation chamber where entry is restricted to individuals wearing self-contained breathing apparatus when a fumigation is being conducted. This restricted area allows dispersion and mixing of methyl bromide with ambient air which forms a buffer zone to assure safe concentrations in the surrounding areas. Therefore, risks of adverse effects to the public should not be a concern.

There may be unacceptable risks of adverse effects from exposures greater than the TLV within close proximity of the aeration outlet of the fumigation chamber during the initial phases of aeration. However, because regulatory fumigations require that unprotected individuals be kept out of the fumigation area until the level of methyl bromide drops below the TLV, these unacceptable risks should not be realized in any program-related fumigations.

Accidental exposures to workers that are greater than the level/duration recommended by the ACGIH may cause serious clinical effects. This possibility does exist, especially since the methyl bromide used in these fumigations does not contain a marker chemical that warns workers of its presence. However, methyl bromide fumigations using the methods specified in the Plant Protection and Quarantine Treatment Manual (USDA, APHIS) have a long history of safe operation. Therefore, the likelihood of an accidental exposure resulting in severe illness is extremely remote.

Neurotoxicity

Unintentional or accidental occupational exposures of humans have resulted in a variety of adverse neurologic manifestations (Behrens and Dukes, 1986; Anger et al., 1986; Verberk et al., 1979). The safety requirements of all program fumigations adequately prevent these exposures. The only possibility of neurotoxic effects from fumigations would be the result of an unprotected individual accidentally wandering into the restricted access area around the fumigation chamber. This should not occur if program personnel are properly monitoring the fumigation.

Immunotoxicity

No evidence was found to indicate that methyl bromide causes dermal sensitization, allergic hypersensitivity, or other immune function alteration in laboratory animals or humans.

Genotoxicity and Mutagenicity

Although the mutagenicity of methyl bromide has not been demonstrated in mammalian cells and intact mammals, it is a mutagen to bacteria. Methyl bromide has been shown to cause chromosomal injury to mammalian cells and the inability to induce mutation in mammals probably relates to the greater physiological protection from mutagens in the mammalian system. Adherence to the safety procedures for fumigations in Agency programs prevents exposure to levels of methyl bromide that could cause chromosomal injury and the risks of an accidental exposure of the magnitude that could cause injury are very slight.

Carcinogenicity

The National Toxicology Program found no evidence of carcinogenicity in its review of a 13-week rat study (Danse et al., 1984), which had reported a finding of squamous cell carcinomas in the forestomach of some animals tested. The panel determined that the reported lesions were inflammation and hyperplasia rather than oncogenic effects. The conclusion of the National Toxicology Program was verified by another study (Boorman et al., 1986) where the same experimental design was used and all stomach lesions regressed when methyl bromide exposure ceased. Two chronic studies of rats (diet and inhalation) were both negative for carcinogenicity (Mitsumori et al., 1990; EPA, OPP, 1990a). Methyl bromide is listed by EPA as a class D chemical as related to carcinogenicity. This means that no firm decision has been made regarding the potential to cause cancer, but the results of these bioassays indicate that any risk of carcinogenic effects is unlikely.

Impurities in Formulations Applied

The toxic effects of methyl bromide exposure are considerably more critical than adverse effects from any metabolites or impurities (Honma et al., 1985). No impurities of any toxicological consequence are associated with formulations of methyl bromide.

Synergistic Effects

There is some evidence that methyl chloride may be synergistic with methyl bromide, but this has not been specifically analyzed (Van Wambeke et al., 1982) and this method of control is only used in Europe. No studies were located that analyzed multiple exposures to determine synergistic or antagonistic effects. No risks from synergistic effects of methyl bromide are anticipated in this program.

2. Nonchemical Control Methods

This section summarizes the potential risks to human health and safety from the implementation of nonchemical methods to control Medfly populations.

Nonchemical methods of Medfly control include sterile insect technique, physical control, cultural control, biological control, and biotechnological control.

a. Sterile Insect Technique

Effects on the human population from the use of sterile insect technique as a control method are not likely. The public should not be affected at all, unless by inadvertent involvement in an airplane or ground vehicle accident. The unique design and shielding of the equipment at fly-rearing facilities prevents workers from being accidentally exposed to the radiation used to sterilize the fruit flies. During release of the flies, a worker on the back of a truck could be at risk of being involved in a vehicle accident. However, safety controls are built into the program to minimize accidental injury to workers. The rearing and release of sterile Medflies is expected to have little, if any, impact on human health and safety.

b. Physical Control

Physical controls, including fruit stripping and host elimination, are not likely to have health or safety effects on the human population. Human health risks are limited to workers involved in mechanical accidents resulting from the stripping of fruits and removal of host plants, and from subsequent disposal. Because of environmental considerations, time constraints, and economic concerns, host elimination generally is considered undesirable and is done only on an extremely limited basis. Therefore, the main human health risks from physical controls would be to workers performing fruit stripping and disposal of the fruits. Accidents resulting from these tasks could include falls from trees or ladders, or injuries resulting from carrying heavy loads, or from burning or burying the infested material. One risk to workers picking infested fruits is exposure to unknown pesticides that may have been applied by the farmer or homeowner. However, workers are required to wear gloves, which would protect them from most exposures. For the most part, physical controls do not pose health and safety concerns, except for the possibility of occasional accidents.

c. Cultural Control

The cultural controls that could apply to the Medfly Cooperative Eradication Program include clean culture, special timing of planting or harvesting, and the recommendation for the selection of resistant varieties. None of these control methods is likely to be effective alone, but as individual methods, none represents any risk to human health or safety. However, if used solely in an effort to eradicate the fruit fly, the effects to human health would be similar to those from other ineffective eradication efforts. These would include exposure to unknown pesticides and unknown quantities of pesticides that farmers or homeowners would apply to control the flies.

d. Biological Control

Biological control has questionable applicability for emergency eradication programs and, therefore, probably would not be used alone. The method itself poses little, if any, risk to human health and safety. However, there is much about biological control that remains largely unknown, leaving the question of safety open. As from other methods that, when used alone, prove ineffective in eradicating a pest, the risk to humans could come from exposure to unknown pesticides and unknown quantities of pesticides that farmers or homeowners would use to protect their crops.

e. Biotechnological Control

Biotechnological control is a potential future control method, but is not considered ready for use now (see chapter III, Alternatives); until then, the risks to human health and safety are largely unknown. The process of genetic engineering used to produce the organisms necessary to control insect pests may involve some risks. Radiation or chemical mutagens could be used to alter reproductive capability in the pest, or disrupt other life systems. Under these circumstances, workers could be exposed to radiation or chemicals with adherent potential for risk. However, laboratories involved in these procedures are required to adhere to good laboratory practices which minimize risk to the workers.

f. Male Annihilation

Male annihilation using sticky yellow panels is not expected to pose a risk to human health and safety. The panels kill Medflies simply by trapping them in sticky substance, and although a chemical lure may be incorporated, the toxicity of the lure is very low. In addition, the public is not likely to be exposed to the panels, which are placed out of reach in host trees.

3. Combined Control Methods

This section discusses the potential consequences of combined control methods which, depending upon the alternative, may involve use of chemical pesticides. The risks to human health and safety from the use of those pesticides are discussed under the individual chemical controls.

a. Regulatory Control

Some aspects of the regulatory controls established to prevent the spread of Medfly from infested areas may have potential to affect human health, although the aspects of regulatory control that involve risk would likely involve the use of chemical pesticides. Regulatory controls that designate quarantine areas or regulate movement of potentially infested commodities have little or no impact on human health and safety. The regulatory controls that involve chemical treatments of regulated articles to permit interstate movement of possible Medfly hosts that may potentially pose a risk to the workers responsible are described in detail in the Plant Protection and Quarantine Treatment Manual. These treatments include fumigation with methyl bromide and soil

treatments with diazinon, chlorpyrifos, or fenthion. Risks to human health and safety from the use of these chemical methods are discussed elsewhere in this document.

b. Integrated Pest Management

Integrated pest management involves the use of any or a combination of control methods, as described in chapter III, Alternatives. The potential human health risks from the use of any of these control methods individually are discussed elsewhere in this chapter, and should be referred to as necessary. The possible risk to human health and safety from the combined use of any or all of these control methods have been considered. The control methods that pose the major risk to human health are those that involve the application of chemical pesticides. The possibility of additive or synergistic effects of the combined use of pesticides is considered in the sections on synergism for each chemical under the appropriate control method. A possible risk of using integrated pest management is that human health and safety may be affected if individuals or farmers need to control or eliminate populations of Medflies threatening their crops by using their own pesticides.

4. Hypersensitivity

Hypersensitive humans experience toxicological symptoms and signs at dosage levels much lower than those that are required to produce the same symptoms in the majority of the population. Hypersensitive individuals constitute only a small portion of the total population. If the response of the population being studied follows the varying doses in a normal distribution (bell-shaped curve), the hypersensitive individuals would be expected to be on the left side of the curve. Although a margin of safety factor of 10 (uncertainty factor) has traditionally been used by regulatory agencies (National Academy of Sciences, 1977) to account for intraspecies variation or interindividual variability, human susceptibility to toxic substances has been shown to vary by as much as three orders of magnitude (Calabrese, 1984). Calabrese examined several studies of human responses to chemicals and found that a safety factor of 10 was useful for predicted effects in 80% to 95% of a population.

Based upon the current state of knowledge, individual susceptibility to toxic effects of the chemicals used in the Medfly Cooperative Eradication Program cannot be specifically predicted. The approach used in this risk assessment takes into account much of the variation in human response (Calabrese, 1984). However, unusually sensitive individuals may experience effects even when the HQs indicate that there are no unacceptable risks. The program makes every attempt possible to minimize exposures and assure that residents are notified if malathion bait will be sprayed in their neighborhood; so, sensitive individuals can prevent the possibility of adverse effects from exposure. Only limited amounts of the soil drench chemicals—diazinon, chlorpyrifos, and fenthion—are permitted to be applied to specific areas (to the drip line under infested trees) so that exposure is minimized. Because all residents are notified and an effort is made to contact individuals on the list of especially hypersensitive persons, those individuals can take extra precautions to avoid exposure to the soil drench pesticides, thereby preventing potential hypersensitive responses.

Methyl bromide exposure to the public is not expected because program measures are in effect to prevent accidental entry into restricted areas, so potential hypersensitive responses from program fumigations should be prevented by the required safety procedures.

5. Psychological Effects

Program actions, including pesticide applications, may elicit psychological effects in some members of the general population. During an eradication effort, the public is notified about the pesticide applications and informed that personnel and equipment will be in their neighborhoods to make those applications. Nevertheless, individuals are generally uncomfortable with actions that they cannot control. Literature from environmental and citizen groups that disapprove of the use of pesticides may influence the attitudes of the public and cause additional concern.

Some individuals have expressed a fear of malathion, branding it as a nerve gas. This fear stems from information about a German company, I. G. Farben, whose organophosphate pesticide development led to research into the development and production of nerve gases for the Nazis during World War II. Private individuals have circulated literature to a wide segment of the populations of program areas, implying that malathion is a nerve gas or can have the same effects as a nerve gas. Even though malathion and the other organophosphate pesticides in this program are not nerve gases, there are chemical differences in the classes of compounds, and there are vast magnitudes of difference in their effects, misinformation or misperception could lead to unfounded distrust of the Medfly program.

Some people may be disturbed by the sight of the helicopters overhead during spraying of malathion bait spray. Some individuals who have not seen the notifications may not be aware of the program and may wonder what the helicopters are for and what is being sprayed. Concerns have been raised on behalf of Vietnam veterans, especially those who have been diagnosed with posttraumatic stress syndrome, regarding the use of helicopters in the program. Some have speculated that the use of helicopters may trigger uncontrolled behavior because of memories of fighting in the jungles of Vietnam, but no evidence exists to indicate this has happened in previous programs.

The notification sent out to the affected population states that the public should remain indoors during the spraying operations, cars should be covered, and pets should be taken indoors. Adequate notification and education of the public should minimize the risk of individuals developing psychological traumas from the Medfly program.

6. Noise

The effects of noise from application procedures for the program pesticides have been considered. Aircraft noise and ground application equipment noise occur for only short durations of time and at low frequency of repetition, so that disturbances to humans from program actions are likely to be minimal and temporary. Soil drench applications should not cause any noise disturbance other than minimal equipment noise and conversation of hand applicators. The disturbance of humans by noise from program fumigations with methyl bromide is

likely to be minimal and mostly the result of setting up the fumigation stack, which is a temporary structure.

D. Biological Resources

This section summarizes the quantitative and qualitative risks to nontarget species associated with chemical, nonchemical, and combined control methods used or proposed for use in the Medfly Cooperative Eradication Program. Those risks were based on scenarios that incorporated control methods which could be used across the broad program area, but may not be used in all areas; as such, the risks should be viewed as being very conservative and may even be interpreted by some as being "worst-case." In addition, potential environmental effects were considered for habitats or ecological associations of concern, endangered and threatened species, and biodiversity. Refer to the Nontarget Risk Assessment (APHIS, 1992b), incorporated by reference.

1. Chemical Control Methods

The characterization of risks to nontarget species from Medfly program pesticides was based on the well-accepted paradigm: hazard (toxicity) definition; exposure estimation to each potential receptor (nontarget species) based on program use of each chemical; and risk assessment. Benchmark toxicity values for terrestrial nontarget species were based on the LD_{50}. The LD_{50} is the dose (in milligrams per kilogram (mg/kg) of body weight) that is lethal to 50% of the population tested. These values allow comparison among chemicals. The U.S. Environmental Protection Agency (EPA) has categorized these values for ease of comparison (table V-1).

Table V-1. Toxicity Categories

Habitat	Terminology	Toxicity Level
Terrestrial	Severely toxic	LD_{50}[1] is less than 50 mg/kg
	Moderately toxic	LD_{50} is 50 to 500 mg/kg
	Slightly toxic	LD_{50} is 500 to 5,000 mg/kg
	Very slightly toxic	LD_{50} is 5,000 to 50,000 mg/kg
Aquatic	Very highly toxic	LC_{50}[2] (or EC_{50}) is less than 0.1 ppm (mg/L)
	Highly toxic	LC_{50} is 0.1 to 1 ppm
	Moderately toxic	LC_{50} is 1 to 10 ppm
	Slightly toxic	LC_{50} is 10 to 100 ppm
	Practically nontoxic	LC_{50} is greater than 100 ppm

[1]Dose lethal to 50% of the test organisms.
[2]Concentration which kills 50% of the test organisms.

EAD-APHIS developed exposure models to compare treatment alternatives across ecoregions. This will facilitate planning on a regional scale. Environmental concentrations, which provided the basis of exposure estimates, were derived from transport and fate models (GLEAMS and the EAD-APHIS surface water model) and EPA pesticide residue data. All modeling was based on program application rates and treatment methods.

Risk was characterized by comparing the estimated dose and the benchmark toxicity value. The benchmark values were the LD_1 or LC_1 (the calculated dose lethal to 1% of the population, usually for a surrogate species). These values were estimated from laboratory-derived LD/LC_{50}s (methodology detailed in the Nontarget Risk Assessment, incorporated by reference). This level was chosen because a 1% population loss probably would not be a serious threat to most populations. In addition, the uncertainty associated with assessing risk, because of incomplete and unavailable information, necessitated a conservative approach. All species analyzed were assumed to be exposed to pesticides either directly or indirectly. Therefore, the analysis characterizes risk to the exposed population only.

Environmental monitoring data from previous Medfly eradication efforts were considered and addressed qualitatively where possible. However, much of the monitoring data from recent programs was inadequate for the estimation of risk because of incompleteness, lack of controls, lack of statistical validity, and inability to show an association between cause and effect. Additionally, program operational changes that have occurred limit the usefulness of much of the data. Comparisons were made between calculated risks and actual monitoring data for past programs with the same or similar methods. In general, available monitoring data were consistent with the environmental risks calculated from the models. Literature and monitoring data relative to effects on reptiles and amphibians is notably scarce, therefore modeling was the primary method of estimating risks to them.

EAD-APHIS developed exposure models for terrestrial and aquatic habitats. The terrestrial model considered exposure during the first 24 hours after a single pesticide application. Because aquatic toxicities generally are based on 96-hour exposure, the aquatic model considered 96-hour exposure.

The model for estimating exposure of terrestrial nontarget species to program chemicals [malathion (aerial and ground), diazinon, chlorpyrifos, and fenthion] considered dermal, ingestion, and inhalation exposure. The sum of exposures via all routes was the estimated dose. Diet, grooming, activity patterns and other species-specific parameters were estimated for two scenarios: routine and extreme. The routine scenario characterizes exposure that organisms would likely experience; the extreme scenario generally assumed the animal was more active, it spent more time in the treatment area, and a higher proportion of its diet items were contaminated with pesticide residues. Although exposure is assumed for most species in this analysis, it is important to note that not all individuals in populations will be exposed.

For aquatic species, exposure was equivalent to the concentration of pesticide in the organism's habitat. Four habitats were modeled for malathion: stream, river, pond, and wetland. Pesticide concentrations in aquatic habitats were determined using a combination of the GLEAMS model and the EAD-APHIS surface water model which estimated malathion concentrations in lakes and ponds following a runoff-producing rainstorm. The routine exposure was the 96-hour average pesticide concentration in the aquatic habitat; the extreme exposure was the maximum concentration that occurred over the 96-hour

postspray period. No routine exposure was assumed for soil drench pesticides because these chemicals are not routinely used in water bodies. For the extreme soil drench scenario, EAD-APHIS modeled runoff from a treated orchard into an adjacent ditch. The model predicted movement of soil drenches into the ditch in only the Mississippi Delta and Floridian ecoregions.

Risks to exposed nontarget species were calculated by comparing the exposure estimate to toxicity benchmark values, usually of a surrogate species. The benchmark toxicity value was extrapolated from the laboratory-derived dose lethal to half of the test organisms (LD_{50}) or, for aquatic organisms, the water concentration (LC_{50}). The benchmark toxicity values to which the estimated doses were compared were: the LD_1 for terrestrial species and the LC_1 for aquatic exposure. The test organism selected as a surrogate for each species was the most taxonomically similar species or one of similar size and trophic level. Generally, the lowest literature toxicity value for this species was selected. Benchmark values, representative species, and surrogates used in this analysis are presented for each pesticide in tables V-2 through V-5.

Table V-2. Benchmark Values Used in Hazard Assessment of Malathion

Nontarget Species Analyzed	Data Source—Species or Surrogate	LD_{50} (mg/kg)	LD_1 (mg/kg)
Terrestrial Mammals			
Opossum	Rat	390.0	78.0
Shrew	Mouse	720.0	144.0
Bat	Mouse	720.0	144.0
Cottontail	Rabbit	250.0	50.0
Squirrel	Rat	390.0	78.0
Mouse	Mouse	720.0	144.0
Raccoon	Dog	360.0	72.0
Fox	Dog	360.0	72.0
Coyote/Dog	Dog	360.0	72.0
Cat	Dog	360.0	72.0
Deer	Cattle	53.0	10.6
Terrestrial Birds			
Pied-billed grebe	Mallard	1,485.0	297.0
Great blue heron	Mallard	1,485.0	297.0
Cattle egret	Mallard	1,485.0	297.0
Duck	Mallard	1,485.0	297.0
Turkey vulture	Mallard	1,485.0	297.0
Red-tailed hawk	Mallard	1,485.0	297.0
American kestrel	Horned lark	403.0	80.6
Quail	Domestic chicken	150.0	30.0
Killdeer	Horned lark	403.0	80.6
Mourning dove	Domestic chicken	150.0	30.0
Great horned owl	Mallard	1,485.0	297.0
Burrowing owl	Horned lark	403.0	80.6
Nighthawk	Horned lark	403.0	80.6
Hummingbird	Horned lark	403.0	80.6
Belted kingfisher	Horned lark	403.0	80.6

continued

Table V-2, continued.

Nontarget Species Analyzed	Data Source—Species or Surrogate	LD_{50} (mg/kg)	LD_1 (mg/kg)
Terrestrial Birds (continued)			
Northern flicker	Horned lark	403.0	80.6
Kingbird	Horned lark	403.0	80.6
American robin	Horned lark	403.0	80.6
Northern mockingbird	Horned lark	403.0	80.6
European starling	Horned lark	403.0	80.6
Red-winged blackbird	Horned lark	403.0	80.6
Meadowlark	Horned lark	403.0	80.6
House sparrow	Horned lark	403.0	80.6
Terrestrial Reptiles			
Desert iguana	Dog	360.0	72.0
Side-blotched lizard	Carolina anole	2,324.0	462.0
Carolina anole	Carolina anole	2,324.0	462.0
Eastern fence lizard	Carolina anole	2,324.0	462.0
Western fence lizard	Carolina anole	2,324.0	462.0
Canyon lizard	Carolina anole	2,324.0	462.0
Gopher snake	Dog	360.0	72.0
Garter snake	Dog	360.0	72.0
Desert tortoise	Dog	360.0	72.0
Eastern box turtle	Dog	360.0	72.0
Western box turtle	Dog	360.0	72.0
Hognose snake	Dog	360.0	72.0
Terrestrial Amphibians			
Toad	Chicken	150.0	30.0
Tree frog	Chicken	150.0	30.0
Terrestrial Invertebrates			
Earthworm	Earthworm	5.0	1.0
Slug	Earthworm	5.0	1.0
Sow bug	Cockroach	7.2	5.5
Spider	Lacewing	124.1	24.8
Mayfly	Adult fly	13.0	6.0
Dragonfly	Cockroach	7.2	5.5
Grasshopper	Cockroach	7.2	5.5
Lacewing	Lacewing	124.1	24.8
Water strider	Lacewing	124.1	24.8
Beetle, grub	Cockroach	7.2	5.5
Beetle, adult	Lacewing	124.1	24.8
Butterfly	Caterpillar	1,015.8	1.0
Moth	Caterpillar	1,015.8	1.0
Caterpillar	Caterpillar	1,015.8	1.0
Maggot	Adult fly	13.0	6.0
Fly	Adult fly	13.0	6.0
Ant	Ant	0.62	0.2
Honey bee	Honey bee	7.8	1.6
Wasp	Parasitic wasp	2.7	1.7

continued

Table V-2, continued.

Nontarget Species Analyzed	Data Source—Species or Surrogate	LC50 (µg/L)	LC1 (µg/L)
Fish			
Golden shiner	Common shiner	10.0	1.0
Speckled dace	Carp	1,900.0	190.0
Mexican tetra	Banded killifish	240.0	24.0
Silvery minnow	Carp	1,900.0	190.0
Goldfish	Goldfish	10,700.0	1,070.0
Sheepshead minnow	Banded killifish	240.0	24.0
California killifish	Banded killifish	240.0	24.0
Swamp darter	Yellow perch	263.0	26.3
Mosquito fish	Mosquito fish	50.0	5.0
Rainbow trout	Rainbow trout	170.0	17.0
Arroyo chub	Carp	1,900.0	190.0
Bluegill sunfish	Bluegill sunfish	103.0	10.3
Largemouth bass	Largemouth bass	285.0	28.5
Channel catfish	Channel catfish	8,970.0	897.0
Yellow bullhead catfish	Black bullhead catfish	12,900.0	1,290.0
Longnose gar	Largemouth bass	285.0	28.5
Lake chubsucker	Carp	1,900.0	190.0
Aquatic Reptiles			
Snapping turtle	Largemouth bass	285.0	28.5
Western pond turtle	Largemouth bass	285.0	28.5
Water snake	Largemouth bass	285.0	28.5
Aquatic Amphibians (larval forms)			
Bullfrog	Western chorus frog tadpole	200.0	20.0
Tiger salamander	Western chorus frog tadpole	200.0	20.0
Amphiuma	Western chorus frog tadpole	200.0	20.0
Aquatic Invertebrates			
Sponge, freshwater	Crayfish	180.0	18.0
Hydra	Crayfish	180.0	18.0
Leech	Crayfish	180.0	18.0
Clam, freshwater	Crayfish	180.0	18.0
Snail, freshwater	Crayfish	180.0	18.0
Scud	Scud	0.76	0.076
Crayfish	Crayfish	180.0	18.0
Water flea	Water flea	1.0	0.1
Dragonfly, larva	Damselfly, larva	10.0	1.0
Mayfly, larva	Stonefly, larva	0.69	0.069
Stonefly, larva	Stonefly, larva	0.69	0.069
Caddis fly, nymph	Caddis fly, nymph	5.0	0.5
Back swimmer	Caddis fly, nymph	5.0	0.5
Beetle	Caddis fly, nymph	5.0	0.5
Mosquito, larva	Mosquito, larva	385.0	38.5

Table V-3. Benchmark Values Used in Hazard Assessment of Diazinon

Nontarget Species Analyzed	Data Source—Species or Surrogate	LD_{50} (mg/kg)	LD_1 (mg/kg)
Terrestrial Mammals			
Opossum	Rat	76.0	15.2
Shrew	Mouse	82.5	16.5
Bat	Mouse	82.5	16.5
Cottontail	Rabbit	130.0	26.0
Squirrel	Rat	76.0	15.2
Mouse	Mouse	82.5	16.5
Raccoon	Guinea pig	250.0	50.0
Fox	Guinea pig	250.0	50.0
Coyote/Dog	Guinea pig	250.0	50.0
Cat	Guinea pig	250.0	50.0
Deer	Guinea pig	250.0	50.0
Terrestrial Birds			
Pied-billed grebe		NE[1]	NE
Great blue heron		NE	NE
Cattle egret	Mallard	3.50	0.18
Duck		NE	NE
Turkey vulture		NE	NE
Red-tailed hawk	Mallard	3.50	0.18
American kestrel	Red-winged blackbird	2.0	0.4
Quail	Northern bobwhite	3.4	0.68
Killdeer	Red-winged blackbird	2.0	0.4
Mourning dove	Northern bobwhite	3.4	0.68
Great horned owl	Mallard	3.50	0.18
Burrowing owl	Mallard	3.50	0.18
Nighthawk	Red-winged blackbird	2.0	0.4
Hummingbird	European starling	110.0	22.0
Belted kingfisher		NE	NE
Northern flicker	Northern bobwhite	3.4	0.68
Kingbird	European starling	110.0	22.0
American robin	European starling	110.0	22.0
Northern mockingbird	European starling	110.0	22.0
European starling	European starling	110.0	22.0
Red-winged blackbird	Red-winged blackbird	2.0	0.4
Meadowlark	Red-winged blackbird	2.0	0.4
House sparrow	Red-winged blackbird	2.0	0.4
Terrestrial Reptiles			
Desert iguana	Japanese quail	167.0	8.35
Side-blotched lizard	Japanese quail	167.0	8.35
Carolina anole	Japanese quail	167.0	8.35
Eastern fence lizard	Japanese quail	167.0	8.35
Western fence lizard	Japanese quail	167.0	8.35
Canyon lizard	Japanese quail	167.0	8.35

continued

Table V-3, continued.

Nontarget Species Analyzed	Data Source—Species or Surrogate	LD_{50} (mg/kg)	LD_1 (mg/kg)
Terrestrial Reptiles (continued)			
Gopher snake	Japanese quail	167.0	8.35
Garter snake	Japanese quail	167.0	8.35
Desert tortoise	Japanese quail	167.0	8.35
Eastern box turtle	Japanese quail	167.0	8.35
Western box turtle	Japanese quail	167.0	8.35
Hognose snake	Japanese quail	167.0	8.35
Terrestrial Amphibians			
Toad	Bullfrog	>2,000.0	200.0
Tree frog	Bullfrog	>2,000.0	200.0
Terrestrial Invertebrates			
Earthworm	Slug	[2]	200.0
Slug	Slug	[2]	200.0
Sow bug	Ant	10.4	2.1
Spider	Ant	10.4	2.1
Mayfly	Ant	10.4	2.1
Dragonfly	Ant	10.4	2.1
Grasshopper	Ant	10.4	2.1
Lacewing	Ant	10.4	2.1
Water strider	Ant	10.4	2.1
Beetle, grub	Ant	10.4	2.1
Beetle, adult	Ant	10.4	2.1
Butterfly	Caterpillar	8.8	1.8
Moth	Caterpillar	8.8	1.8
Caterpillar	Caterpillar	8.8	1.8
Maggot	Ant	10.4	2.1
Fly	Ant	10.4	2.1
Ant	Ant	10.4	2.1
Honey bee	Honey bee	4.0	0.98
Wasp	Honey bee	4.0	0.98
		LC_{50} (μg/L)	LC_1 (μg/L)
Fish			
Mosquito fish	Guppy	4,000.0	400.0
Aquatic Reptiles			
Snapping turtle	Bluegill sunfish	22.0	2.0
Water snake	Bluegill sunfish	22.0	2.0
Aquatic Amphibians (larval forms)			
Tiger salamander	Bluegill sunfish	22.0	2.0
Amphiuma	Bluegill sunfish	22.0	2.0
Aquatic Invertebrates			
Leech	Water flea	0.8	0.08
Snail, freshwater	Water flea	0.8	0.08
Crayfish	Scud	0.2	0.02

continued

Table V-3, continued.

Nontarget Species Analyzed	Data Source—Species or Surrogate	LC_{50} (µg/L)	LC_1 (µg/L)
Aquatic Invertebrates (continued)			
Dragonfly, juvenile	Stonefly larva	25.0	2.5
Mosquito, larva	Stonefly larva	25.0	2.5

[1]NE = No exposure anticipated.
[2]LD_1 not derived from LD_{50}.

Table V-4. Benchmark Values Used in Hazard Assessment of Chlorpyrifos

Nontarget Species Analyzed	Data Source—Species or Surrogate	LD_{50} (mg/kg)	LD_1 (mg/kg)
Terrestrial Mammals			
Opossum	Guinea pig	500.0	100.0
Shrew	Mouse	62.0	12.4
Bat	Mouse	62.0	12.4
Cottontail	Rabbit	1,000.0	200.0
Squirrel	Guinea pig	500.0	100.0
Mouse	Mouse	62.0	12.4
Raccoon	Guinea pig	500.0	100.0
Fox	Goat	500.0	100.0
Coyote/Dog	Goat	500.0	100.0
Cat	Goat	500.0	100.0
Deer	Goat	500.0	100.0
Terrestrial Birds			
Pied-billed grebe		NE[1]	NE
Great blue heron		NE	NE
Cattle egret	Mallard	75.60	7.60
Duck		NE	NE
Turkey vulture		NE	NE
Red-tailed hawk	Mallard	75.6	7.6
American kestrel	Red-winged blackbird	13.0	1.3
Quail	California quail	68.9	5.25
Killdeer	Red-winged blackbird	13.0	1.3
Mourning dove	Mourning dove	26.9	2.69
Great horned owl	Mallard	75.6	7.6
Burrowing owl	Mallard	75.6	7.6
Nighthawk	Northern bobwhite	32.0	2.46
Hummingbird	Red-winged blackbird	13.0	1.3
Belted kingfisher		NE	NE
Northern flicker	American crow	32.0	3.2
Kingbird	American crow	32.0	3.2
American robin	European starling	5.0	0.5
Northern mockingbird	European starling	5.0	0.5

continued

Table V-4, continued.

Nontarget Species Analyzed	Data Source—Species or Surrogate	LD_{50} (mg/kg)	LD_1 (mg/kg)
Terrestrial Birds (continued)			
European starling	European starling	5.0	0.5
Red-winged blackbird	Red-winged blackbird	13.0	1.3
Meadowlark	Red-winged blackbird	13.0	1.3
House sparrow	House sparrow	10.0	1.0
Terrestrial Reptiles			
Desert iguana	Bobwhite quail	32.0	3.2
Side-blotched lizard	Bobwhite quail	32.0	3.2
Carolina anole	Bobwhite quail	32.0	3.2
Eastern fence lizard	Bobwhite quail	32.0	3.2
Western fence lizard	Bobwhite quail	32.0	3.2
Canyon lizard	Bobwhite quail	32.0	3.2
Gopher snake	Bobwhite quail	32.0	3.2
Garter snake	Bobwhite quail	32.0	3.2
Desert tortoise	Bobwhite quail	32.0	3.2
Eastern box turtle	Bobwhite quail	32.0	3.2
Western box turtle	Bobwhite quail	32.0	3.2
Hognose snake	Bobwhite quail	32.0	3.2
Terrestrial Amphibians			
Toad	Bullfrog	>400.0	40.0
Tree frog	Bullfrog	>400.0	40.0
Terrestrial Invertebrates			
Earthworm	Earthworm	0.066	0.0015
Slug	Snail	3.0	0.5
Sow bug	Cricket	0.0795	0.022
Spider	Beetle	1.4	0.0014
Mayfly, adult	Lacewing, larva	2.1	0.0081
Dragonfly	Beetle	1.4	0.0014
Grasshopper	Cricket	0.0795	0.022
Lacewing, larva	Lacewing, larva	2.1	0.0081
Water strider	Beetle	1.4	0.0014
Beetle, grub	Beetle	1.4	0.0014
Beetle, adult	Beetle	1.4	0.0014
Butterfly	Caterpillar	5.13	1.3
Moth	Caterpillar	5.13	1.3
Caterpillar	Caterpillar	5.13	1.3
Maggot	Caterpillar	5.13	1.3
Fly	Honey bee	0.108	0.036
Ant	Ant	0.39	0.078
Honey bee	Honey bee	0.108	0.036
Wasp	Honey bee	0.108	0.036

continued

Table V-4, continued.

Nontarget Species Analyzed	Data Source— Species or Surrogate	LC_{50} (μg/L)	LC_1 (μg/L)
Fish			
Mosquito fish	Mosquito fish	280.0	28.0
Aquatic Reptiles			
Snapping turtle	Largemouth bass	0.58	0.058
Water snake	Largemouth bass	0.58	0.058
Aquatic Amphibians (larval forms)			
Tiger salamander	Largemouth bass	0.58	0.058
Amphiuma	Largemouth bass	0.58	0.058
Aquatic Invertebrates			
Leech	Scud	0.11	0.011
Snail, freshwater	Scud	0.11	0.011
Crayfish	Scud	0.11	0.011
Dragonfly, juvenile	Stonefly, larva	0.57	0.057
Mosquito, larva	Stonefly, larva	0.57	0.057

[1]NE = No exposure anticipated.

Table V-5. Benchmark Values Used in Hazard Assessment of Fenthion

Nontarget Species Analyzed	Data Source— Species or Surrogate	LD_{50} (mg/kg)	LD_1 (mg/kg)
Terrestrial Mammals			
Opossum	Rat	250.0	50.0
Shrew	Mouse	150.0	30.0
Bat	Mouse	150.0	30.0
Cottontail	Rabbit	25.0	6.0
Squirrel	Rat	250.0	50.0
Mouse	Mouse	150.0	30.0
Raccoon	Rat	250.0	50.0
Fox	Rat	250.0	50.0
Coyote/Dog	Rat	250.0	50.0
Cat	Rat	250.0	50.0
Deer	Rat	250.0	50.0
Terrestrial Birds			
Pied-billed grebe		NE[1]	NE
Great blue heron		NE	NE
Cattle egret	Mallard	5.94	0.5
Duck		NE	NE
Turkey vulture		NE	NE
Red-tailed hawk	American kestrel	1.4	0.12
American kestrel	American kestrel	1.4	0.12
Quail	California quail	15.0	0.79
Killdeer	Red-winged blackbird	1.8	0.15
Mourning dove	Mourning dove	2.68	0.22

continued

Table V-5, continued.

Nontarget Species Analyzed	Data Source—Species or Surrogate	LD_{50} (mg/kg)	LD_1 (mg/kg)
Terrestrial Birds (continued)			
Great horned owl	Eastern screech owl	3.9	0.81
Burrowing owl	Eastern screech owl	3.9	0.81
Nighthawk	Red-winged blackbird	1.8	0.15
Hummingbird	Red-winged blackbird	1.8	0.15
Belted kingfisher		NE	NE
Northern flicker	European starling	5.3	0.44
Kingbird	European starling	5.3	0.44
American robin	European starling	5.3	0.44
Northern mockingbird	European starling	5.3	0.44
European starling	European starling	5.3	0.44
Red-winged blackbird	Red-winged blackbird	1.8	0.15
Meadowlark	Red-winged blackbird	1.8	0.15
House sparrow	House sparrow	22.7	1.89
Terrestrial Reptiles			
Desert iguana	Screech owl	3.9	0.26
Side-blotched lizard	Screech owl	3.9	0.26
Carolina anole	Screech owl	3.9	0.26
Eastern fence lizard	Screech owl	3.9	0.26
Western fence lizard	Screech owl	3.9	0.26
Canyon lizard	Screech owl	3.9	0.26
Gopher snake	Screech owl	3.9	0.26
Garter snake	Screech owl	3.9	0.26
Desert tortoise	Screech owl	3.9	0.26
Eastern box turtle	Screech owl	3.9	0.26
Western box turtle	Screech owl	3.9	0.26
Hognose snake	Screech owl	3.9	0.26
Terrestrial Amphibians			
Toad	Red-winged blackbird	1.8	0.12
Tree frog	Red-winged blackbird	1.8	0.12
Terrestrial Invertebrates			
Earthworm	Snail (chlorpyrifos)	3.0	0.5
Slug	Snail (chlorpyrifos)	3.0	0.5
Sow bug	Face fly	1.9	0.24
Spider	Face fly	1.9	0.24
Mayfly	Face fly	1.9	0.24
Dragonfly	Face fly	1.9	0.24
Grasshopper	Face fly	1.9	0.24
Lacewing	Face fly	1.9	0.24
Water strider	Face fly	1.9	0.24
Beetle, grub	Face fly	1.9	0.24
Beetle, adult	Face fly	1.9	0.24
Butterfly	Face fly	1.9	0.24

continued

Table V-5, continued.

Nontarget Species Analyzed	Data Source—Species or Surrogate		
		LD_{50} (mg/kg)	LD_1 (mg/kg)
Terrestrial Invertebrates (continued)			
Moth	Face fly	1.9	0.24
Caterpillar	Face fly	1.9	0.24
Maggot	Face fly	1.9	0.24
Fly	Face fly	1.9	0.24
Ant	Honey bee	34.3	0.55
Honey bee	Honey bee	34.3	0.55
Wasp	Honey bee	34.3	0.55
		LC_{50} (μg/L)	LC_1 (μg/L)
Fish			
Mosquito fish	Mosquito fish	2,000.0	200.0
Aquatic Reptiles			
Snapping turtle	Largemouth bass	1,540.0	154.0
Water snake	Largemouth bass	1,540.0	154.0
Aquatic Amphibians (larval forms)			
Tiger salamander	Bullfrog tadpole	500.0	50.0
Amphiuma	Bullfrog tadpole	500.0	50.0
Aquatic Invertebrates			
Leech	Scud	8.4	0.84
Snail, freshwater	Scud	8.4	0.84
Crayfish	Crayfish	50.0	5.0
Dragonfly, juvenile	Stonefly, larva	4.5	0.45
Mosquito, larva	Stonefly, larva	4.5	0.45

[1]NE = No exposure anticipated.

Tables V-6 to V-10, beginning on page 137, estimate the calculated mortality rates for individuals of nontarget species that are exposed to the program pesticides. (The tables follow the discussions on each pesticide and are presented as a unit to facilitate comparison of the data.) Estimated mortality rates were calculated for each species and each chemical using the estimated dose predicted by the exposure model and the dose-response curve for the species or a surrogate species from a laboratory toxicological study (see the Nontarget Risk Assessment, APHIS 1992b, for details on this method). Individuals of any species for which estimated mortality exceeded 1% are considered at risk; species with mortality estimates exceeding 99% were considered to be at a high degree of risk. These values were calculated from the routine exposure estimates. It must be emphasized that the calculated mortality rates shown in the tables were for individuals that are exposed to the program pesticides; the tables are not intended to reflect and should not be interpreted to reflect mortality rates for nontarget species populations across the entire program area.

Information gaps in each step of the risk analysis lead to much inherent uncertainty. Toxicity information is primarily from laboratory studies on laboratory animals. The dose-response curve is undoubtedly different for wild populations under field conditions where other stressors could magnify or ameliorate the effect of the pesticide. These studies are conducted with a range

of formulations, rarely those used in the Medfly program. In addition, few studies have been conducted using malathion bait spray. The protein hydrolysate undoubtedly would affect the toxicity in some way. Toxicity data are available for very few species, requiring the selection of a surrogate species for analysis. Often there were no data for similar species, and selection was based primarily on sensitivity. The choice of a surrogate had a great effect on the assessment of risk.

Because environmental fate is site-specific, the pesticides may not act as modeled at every site (i.e., may degrade more or less quickly and travel farther). EAD-APHIS exposure models required the estimation of a variety of characteristics for the species under analysis, e.g., diet and activity patterns. These input parameters cannot take into account the temporal and seasonal variability nor behavioral response characteristics within a species. Nonetheless, because a uniform approach was taken, the results allow comparison of relative risks across taxa and across ecoregions.

Table V-11, beginning on page 150, presents a summary of risk to individuals of nontarget species that are exposed to the program pesticides. As before, the information pertains only to those individuals that are exposed rather than entire populations of nontarget species within the entire program area. Because of the precise targeting of Medfly host material with most of the chemical methods, many, if not most, of the nontarget species within a program area will not be exposed. Aerial malathion bait spray is expected to affect a larger proportion of the population than ground application of malathion bait and the soil drenches because it is applied to a larger proportion of the treatment area. Ground-applied malathion bait is estimated to cover 10% of the treatment area and the soil drenches will cover 0.2% of the treatment area.

a. Bait Spray Applications

(1) Malathion Aerial Application

(a) Hazard Assessment

Malathion is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition. The acute oral toxicity of malathion is slight for humans and very slight to moderate for other mammals. The acute toxicity of malathion by the dermal route is one of the lowest of the organophosphorus insecticides. Malathion is a very slight dermal irritant and a slight eye irritant.

Malathion is very slightly to moderately toxic for mammals, slightly to moderately toxic for birds, moderately to severely toxic for terrestrial invertebrates, and of low phytotoxicity for most plants. Malathion is slightly to very highly toxic for fish, highly toxic for immature aquatic stages of reptiles and amphibians, and moderately to very highly toxic for aquatic invertebrates.

(b) Exposure Analysis

From modeling, the terrestrial invertebrates were anticipated to receive the highest total malathion doses of any of the terrestrial organisms (most species had total doses greater than 100 mg of malathion per kilogram of body mass). Vertebrate insectivorous species had higher total doses than other vertebrate omnivores, herbivores, or noninsect carnivores. Vertebrate nectar feeders (hummingbirds) and invertebrate nectar feeders (honey bees) also displayed high total doses of malathion. Predatory invertebrates (orb web spider, adult beetle, and parasitic wasp), invertebrates with high metabolic requirements (caterpillars and maggots), and invertebrates with high activity rates and frequent contact with malathion residues (ants and honey bees) had higher total doses than other terrestrial organisms.

Vertebrates exhibited exposures ranging from 10 mg/kg to 100 mg/kg. Smaller species tended to have higher total doses than larger species because small species have higher metabolic rates (and need to consume more food per body mass) and also are more active than large species (contacting malathion more frequently resulting in higher dermal exposures).

Total doses for all types of terrestrial organisms were higher in the western ecoregions (California Central Valley and Coastal, Southwestern Basin and Range, and Lower Rio Grande Valley). This assumed that the sparse vegetative cover in these areas allowed a larger proportion of the malathion bait spray to penetrate the canopy to the level where the organism would be exposed.

Ingestion was considered to be the dominant route of exposure for all but a few of the vertebrates. Inhalation was negligible for all taxa. Ingestion and dermal exposure were approximately equal for most of the invertebrates. For moths and butterflies, dermal exposure was greater than ingestion due to limited grooming and dietary intake. For invertebrates living in the soil, dermal was usually the dominant type of exposure depending on the amount of time spent at the soil surface.

For aquatic organisms, exposure estimates were equivalent to the malathion concentration in the water body in which they occurred. Malathion concentration in water was correlated to water body depth; organisms living in shallower water bodies had higher total doses than those living in deeper habitats. The highest malathion concentrations, and thus the highest total doses, were observed in wetlands and shallow ponds. There were no ecoregion differences in extreme exposure in wetlands and ponds. The highest total doses under the routine scenario for the pond and wetland were in the Southwestern Basin and Range and the Southeastern and Gulf Coastal Plain ecoregions, respectively.

Inadvertent direct spray was assumed for all habitats. Some water bodies also received runoff from the treatment area. Malathion concentrations were dependent upon the amount of runoff expected following a rain storm and the soil-specific degradation rate. Ecoregion differences in total doses were noted for water bodies receiving runoff water (lakes and streams). Highest total

doses in the stream and lake were predicted in the three western ecoregions and in the Southwestern Basin and Range ecoregion, respectively.

(c) Risk Assessment

Table V-6 summarizes the estimated risk to nontarget species resulting from aerial spraying of malathion bait. Terrestrial and aquatic invertebrates are at risk throughout the treatment area because of high exposures and toxicity. Exposed invertebrate populations would be expected to be severely reduced for aquatic species, such as mayflies, stone flies, caddis flies, scuds, water fleas, back swimmers, and aquatic beetles, and all terrestrial species.

The terrestrial invertebrates, particularly insects exposed to bait spray, are likely to have depressed populations for a given period of time following spraying. The treatment area and number of treatments will influence the ability of the population to become reestablished. The ability to reestablish the population is also influenced by the distance from the treatment area to similar, untreated habitats containing potential colonists, and the ability of these potential colonists to disperse. Limiting the bait spray either by selective applications to smaller more critical areas or using only ground applications allows these populations better chances for earlier recovery to their previous population levels.

Dahlsten (1985) examined effects of malathion bait spray on nontarget invertebrates and concluded there was a "significant effect of the Medfly malathion bait spray on several nontarget insects on urban and suburban trees." These effects included: direct knockdown (kill) of species such as flies, caterpillars, and small wasps; an increase in populations of pest species as a result of damage to populations of beneficial insects; and stimulation of pest reproduction (whiteflies). Although no specific information was provided concerning recovery of populations, the author stated that long-term residual effects were likely.

The elimination of predatory insects would allow insect pest populations to increase. These outbreaks have been observed and "were attributed to destruction of natural enemies by malathion. In general, concentrations of malathion bait sufficient to kill most adult parasites tested were less toxic to the pest species tested. These results indicate that future (Medfly) eradication programs which employ numerous sequential applications of malathion bait spray can be expected to disrupt a substantial portion of the biological control which exists in the target zone" (Ehler and Endicott, 1984).

Troetschler (1983) compared nontarget arthropod populations in a Medfly eradication treatment area (Palo Alto, California) with unsprayed control areas (Hayward and Jasper Ridge, California). "A variety of polyphagous and carnivorous arthropods were attracted by the baits, and in most cases fewer numbers were caught in treated than in control areas." Soil dwellers, polyphagous beetles, some fly species, ants, and wasps were reduced in the treated area; no spiders or predaceous beetles were trapped. Lepidopterous larvae and aphid and whitefly populations were higher in the spray zone. Populations of muscoid flies were not reduced. She concluded, "When bait

sprays are applied full cover over many months over a wide area, recovery of some species may require 1 year or more."

EAD-APHIS modeling predicts that lepidopterans (butterflies, moths, and caterpillars) are less affected than many other insects by malathion bait spray. The predicted loss of soil invertebrates could affect nutrient cycling rates in the ecosystem. Loss of earthworms could affect the physical characteristics of the soil by reducing pore space and aeration which could potentially affect plant growth.

Modeling also predicts honey bees are at risk throughout the treatment area in all of the ecoregions, with estimated exposures of 700 times the median lethal dose. Unprotected honey bee hives would be expected to suffer substantial mortality and this has been found to occur. Gary and Mussen (1984) state: "We conclude that the impact of Medfly malathion bait spray on honey bees is significant. Although colonies recovered satisfactorily after cessation of spraying during the spring and early summer, there would be a significant risk if spraying were done later in the summer when there is insufficient time for populations to return to normal levels before winter begins . . . Although Medfly malathion bait spray is a threat to honey bee colonies, we conclude that the overall economic benefits of controlling the destructive Medfly are far greater than the transient losses incurred by beekeepers."

The timing and frequency of spraying have a great impact on the species alterations. Washburn et al (1983) found: "Few adult natural enemies survived one spray, but populations recovered quickly . . . Timing of spray regimes could qualitatively as well as quantitatively alter the community composition. Whether the balance of the system is shifted to favor the scale [pest species] or the natural enemies depends on the frequency and seasonal timing of the applications."

Some vertebrates may be at risk including insectivorous mammals (bat and shrew) and the terrestrial amphibians. Birds are not anticipated to suffer mortality in the program area due to malathion aerial spraying.

Species which depend upon invertebrates for part of their diet would be affected by the aerial spray program due to a reduction in food supply even if they suffer no direct mortality. Effects would be greatest for predators with restricted mobility. Field studies have shown that mammals, birds, reptiles, and terrestrial amphibians are unlikely to be affected by direct toxicity, but some species dependent upon insects for food (insectivores) or pollination of food plants could be stressed by environmental conditions that result from malathion applications. Plants dependent upon invertebrates for pollination would also be affected, as well as animals dependent upon the fruits of these plants.

In aquatic systems, fish in shallow water bodies, such as wetlands or ponds less than 1 ft deep, are at risk because of the elevated (more than 59 μg/L) malathion concentrations in these habitats. Individuals of sensitive species, such as bluegills or shiners, are also at risk in ponds, streams, and some lakes.

Commercially reared crayfish and shrimp are at risk in shallow ponds less than 1 ft deep in every ecoregion. In deeper ponds, these species are not at risk. Aquatic reptiles and amphibians are at risk in wetlands. Many aquatic insect larva are anticipated to be affected.

Field studies of the 1981 Medfly eradication program in Santa Clara County, California, indicate the total number of aquatic insects remained constant following spraying, but species composition changed and diversity declined, favoring those insects more tolerant of malathion. Adverse effects to fish are localized and may be limited to only highly sensitive species if applications are limited to the dry season when runoff is not a major concern. Fish losses that were attributed to malathion use in the 1981 San Francisco Medfly Program occurred in shallow creeks during the dry season as well as in larger streams during the wet season (CDFG, 1982). California has altered aerial application practices to avoid conditions which would result in high concentrations of malathion in runoff.

Exposure to malathion bait spray or to the noise made by aircraft could cause behavioral changes in some organisms causing them to leave the treatment area, become more susceptible to predation, or become unable to either reproduce or care for young. No pertinent studies are available relative to effects of Medfly programs on such behavioral changes.

(2) Ground Application of Malathion Bait

(a) Hazard Assessment

The toxicity and hazards of malathion have been discussed previously. The same formulation is used for both aerial and ground applications. Ground applications may range from spot treatments (part of a host tree) to full foliar coverage of the host plants. Hazards and resultant risks would be higher for full foliar coverage applications than for spot treatments because of the greater amount of pesticide used. Because of the potential for using full foliar coverage applications in a future program, the risk assessment has been based on that type of application.

(b) Exposure Analysis

As with aerial application, the EAD-APHIS model predicted small insectivores had the highest exposures, the large herbivores and aquatic foraging species the least. The highest total invertebrate exposures were to predators (orb web spider, lacewing larva, and parasitic wasp) and to those with high dermal exposure, such as maggot.

Ingestion was the primary exposure route for the vast majority of vertebrate species. Estimated dermal and ingestion exposures were about equal for invertebrates, although dermal exposure was higher for fossorial invertebrates, spiders, butterflies, and moths (the latter feed little as adults). Total doses in the eastern ecoregions were, in general, higher than in western ecoregions. The ecoregion differences in total dose are related to differences in the

malathion concentration in prey items, as the dermal dose did not differ greatly among ecoregions.

No aquatic exposure was assumed under routine ground application of malathion bait. However, because of soil characteristics, runoff is anticipated in the Mississippi Delta and Floridian ecoregions. This is predicted to result in aquatic concentrations ranging from 0.03 to 3.1 μg/L in less than 2 m deep habitat.

(c) Risk Assessment

Table V-7 provides a summary of the estimated risk to nontarget terrestrial species from ground spraying of malathion on foliage. Of the nontarget terrestrial species, the invertebrate species are at most risk from this treatment method. All terrestrial invertebrates modeled under both routine and extreme scenarios had estimated mortality rates greater than 99% except spider, beetle, butterfly, moth, caterpillar, and water strider. Amphibians that have a high proportion of their diet items containing residues from malathion ground spraying are at lesser risk. No mammal, bird, or reptile species analyzed had doses that exceeded the LD_1 values.

Ground spraying of malathion, because it is applied to small areas relative to the size of birds' and most mammals' home ranges, poses less risk to these populations than aerial spraying. Animals that feed extensively beneath a sprayed tree, or nest or forage within it, would receive the highest doses.

Ichinohe et al (1977) treated foliage with malathion ground spray and concluded: "It is clearly evident from results that proteinaceous bait is effective against fruit flies and also against many insects belonging to Diptera, Blattaria, Orthoptera, Homoptera and Psocoptera."

The study lacked controls and had "no information on population density of each species." They detected secondary poisoning (from eating contaminated prey items) as the cause of mortality in spiders.

Estimated mortality rates for ground applications are much lower than for aerial applications because of the more limited nature of ground applications, even though the maximum was modeled. Insects have a high reproductive rate and most are ubiquitous. Because ground application of foliar sprays cover small areas, sufficient interspersion of unaffected areas which support invertebrates would provide a population base for repopulating treated areas. Except for populations characterized by low numbers, there should be sufficient numbers from neighboring untreated areas. However, depending on the time of year, commercially important species, such as the honey bee and other pollinators, could experience such population reductions as to result in secondary effects on many plants, including agricultural crops (if a broadscale program was conducted on agricultural lands). Severe reductions in predatory insect populations have resulted in an increase in some pest species. Because malathion ground spraying is localized, however, these effects are unlikely to be widespread.

Potential direct impacts on vegetation are unlikely because malathion is not phytotoxic. Indirect impacts on vegetation could occur, because malathion is toxic to bees and probably to other insect pollinators. Notification of apiary operators prior to spray activities should limit any potential losses for commercial crops. Effects would be expected to be limited and local, and long-term reductions in insect pollinator populations are not anticipated from ground spraying due to recruitment of populations from unsprayed areas.

Aquatic organisms are not at risk from ground spraying of malathion under the routine scenario.

Nontarget organisms could be disturbed by the treatment. Mobile species could leave the area and would suffer no adverse effect unless resources could not be found elsewhere. Effects would be greater on species that could not relocate (e.g., nestlings). Precautions should be taken to ensure domestic animals do not contact the treated area.

b. Soil Treatments

(1) Diazinon

(a) Hazard Assessment

Diazinon is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition. AChE inhibition can cause muscle tremors, convulsions, behavioral changes, and other symptoms. Death usually occurs due to respiratory failure, but death of wild animals may also be the result of behavioral changes (i.e., loss of ability to evade predators).

Diazinon is very slightly to moderately toxic for mammals, severely toxic for birds, slightly toxic for reptiles and terrestrial amphibians, severely toxic for terrestrial invertebrates, and of low phytotoxicity to most plants. Field studies have shown that all birds are sensitive to diazinon including songbirds and other birds found in backyard settings (Smith, 1987).

Diazinon is moderately to highly toxic to fish and very highly toxic to aquatic invertebrates. Field studies of fish communities exposed to diazinon are few. The aquatic invertebrate populations as a whole have been shown to remain constant in numbers following spraying, but the species diversity shifts in favor of those insects more tolerant of diazinon.

Diazinon degrades rapidly on plants with a typical half-life of less than 14 days. Diazinon can translocate from soil into roots and leaves, but due to its rapid degradation, bioaccumulation is not generally a concern in plants.

(b) Exposure Analysis

Exposure of nontarget organisms to diazinon depends on one major factor—whether or not the individual organism is in or near the limited area in which the soil drench chemical is applied. Because the area treated with diazinon is

small, the majority of individuals in a program area will not contact this chemical.

For those terrestrial species that feed in, traverse, or inhabit areas treated with diazinon, the primary route of exposure is ingestion (usually of insects killed or incapacitated by the chemical). For insects, both dermal exposure and ingestion of contaminated plant material or prey contribute substantially to diazinon dose. Invertebrates and small mammals received the highest doses and the carnivorous birds received the lowest doses. Exposures of terrestrial species to diazinon were generally higher in the eastern ecoregions.

Aquatic organisms will have extremely limited exposure to diazinon because it is not used in aquatic areas. Even under the extreme scenario (a ditch adjacent to an orchard treated with diazinon), rainfall will not wash any appreciable amount of diazinon into aquatic areas in four ecoregions. However, in the Mississippi Delta and Floridian ecoregions, fish, invertebrates and other aquatic species in an adjacent ditch could be exposed to low concentrations (0.1 to 12.2 μg/L) of diazinon due to runoff.

(c) Risk Assessment

Diazinon presented a risk (greater than 1% mortality) to most of the exposed individuals that were considered under the assumptions of this analysis. Exposed terrestrial species within this analysis that were at risk from diazinon include many mammals, most of the birds, all of the terrestrial reptiles and invertebrates, and all amphibians. Insects, small mammals, insectivorous lizards, and insectivorous birds are likely to suffer the highest mortality of those individuals exposed to diazinon. However, population mortality in the treatment area is not anticipated to be high for any species analyzed. Aquatic invertebrate species are at risk from diazinon washed into a ditch in the Mississippi Delta and Floridian ecoregions only under the extreme scenario.

Diazinon use in a recent Florida Medfly program was restricted (by EPA) to no more than 10 gallons per year; actual usage in California's recent programs has been substantially less. Opportunity for exposure is minimal and only species that use or traverse treated areas are exposed. Those include territorial birds, tree lizards, small mammals with limited mobility, and insects. The primary effect of diazinon on nontarget species is high mortality of soil invertebrate fauna, possibly resulting in lower fertility and soil aeration. Effects would be localized.

(2) Chlorpyrifos

(a) Hazard Assessment

Chlorpyrifos is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition. AChE inhibition can cause muscle tremors, convulsions, behavioral changes, and many other symptoms. Death usually occurs from respiratory failure, although death of wild animals may also be indirect, the result of behavioral changes such as loss of ability to evade predators. EPA's 1989 registration standard for chlorpyrifos identifies

environmental toxicity data gaps for active ingredient, typical end-use product, and degradate as well as environmental fate.

Chlorpyrifos is moderately toxic for mammals, severely to moderately toxic for birds, moderately or less toxic for adult reptiles and amphibians, slightly to very highly toxic for tadpoles, and severely toxic to terrestrial invertebrates. Chlorpyrifos is particularly toxic for earthworms, bees, some other beneficial insects and some birds including European starling and ring-necked pheasant. Field studies have shown that wild bees, such as the alfalfa leafcutting bee and alkali bee, are even more sensitive to chlorpyrifos than honey bees (Johansen, 1977).

Chlorpyrifos is very highly toxic to fish and aquatic invertebrates. Important fish food species, such as scuds (*Gammarus* sp.) and stonefly naiads, are the most sensitive aquatic invertebrates tested. Early instar larvae may be even more sensitive than adults. Marine fish (striped bass and Atlantic silverside) seem to be slightly more sensitive than freshwater species (bluegill sunfish and rainbow trout). Field tests of chlorpyrifos in ponds, streams, and wetlands have confirmed its toxicity to mosquito fish, killifish, and aquatic invertebrates (Smith, 1987). Cyanobacteria and fish bioaccumulate or bioconcentrate chlorpyrifos up to 1,000 times, which means that secondary poisoning could be a problem although it has not been documented.

(b) Exposure Analysis

Exposure of nontarget organisms to chlorpyrifos depends on proximity of the individual organism to the limited area in which the soil drench chemical is applied. Because the chlorpyrifos-treated area is small, the majority of individuals in a program area are unlikely to come into contact with this chemical.

For terrestrial vertebrate species who do feed in, traverse, or inhabit areas treated with chlorpyrifos, the primary route of exposure is ingestion, usually of insects killed or incapacitated by the chemical. For the insects themselves, both dermal exposure as well as ingestion of contaminated plant material or prey contribute substantially to the chlorpyrifos dose. Among the various groups of terrestrial organisms, invertebrates and small mammals received the highest doses. Exposure of terrestrial species to chlorpyrifos is generally higher in the eastern ecoregions.

Aquatic organisms will have extremely limited exposure to chlorpyrifos because it is not used in aquatic areas. In an extreme case modeled (a ditch adjacent to an orchard treated with chlorpyrifos), rainfall washed some chlorpyrifos into aquatic areas in two of the six ecoregions. In the Mississippi Delta and Floridian ecoregions, fish, invertebrates, and other aquatic species could be exposed to substantial concentrations of chlorpyrifos (35.5 to 221.8 µg/L) washed into a ditch.

(c) Risk Assessment

Chlorpyrifos represents a risk (greater than 1% mortality) to small mammals (shrews, mice, and bats), birds except for aquatic feeders and higher predators,

and all terrestrial reptiles, amphibians, and terrestrial invertebrates (table V-9). Population mortality is projected to be low for all species in the treatment area because of the limited use of the pesticide.

Chlorpyrifos represents more of a risk to aquatic species than does diazinon or fenthion. All aquatic species exposed via runoff into a ditch, in the extreme scenario, are at risk except for fish exposed to the lower application rate in the Floridian ecoregion.

If chlorpyrifos were part of a Medfly program, its use would most likely be subject to the same restrictions that apply to diazinon. Because of the limited use, it is projected that a maximum of 0.14% of the program area would be treated. Although chlorpyrifos represents a substantial risk to exposed individuals, nontarget populations as a whole are not at risk. However, as with diazinon, soil fauna are at great risk in the treatment area. Local conditions determine degradation and affect the time required for repopulation.

(3) Fenthion

(a) Hazard Assessment

Fenthion is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition. AChE inhibition can cause muscle tremors, convulsions, behavioral changes, and many other symptoms. Death usually occurs due to respiratory failure although death of wild animals could also result from indirect causes such as behavioral changes (i.e., loss of ability to evade predators). EPA's registration standard for fenthion (1988) lists data gaps for environmental fate, acute and chronic toxicity, and environmental toxicity for active ingredient, typical end-use product, and degradation product.

Fenthion is moderately toxic to mammals, severely toxic to birds, and severely toxic to terrestrial invertebrates. Its toxicity to reptiles and amphibians is uncertain, but it is probably moderately toxic. Animals such as bullfrog tadpoles and carp can bioconcentrate fenthion up to 2,300 times and retain about half of that residue for several weeks. Fenthion is most toxic to birds, aquatic invertebrates, and honey bees. Of particular concern with respect to birds is the demonstrated capacity for secondary poisoning via treated or poisoned diet items.

Fenthion is highly toxic to fish and very highly toxic to aquatic invertebrates. Of the aquatic invertebrates, mysid and pink shrimp as well as first instar larvae of water fleas are most sensitive. Field studies in Florida estuaries have confirmed fenthion's toxicity to aquatic invertebrates (Clark et al., 1987a).

(b) Exposure Analysis

Exposure of nontarget organisms to fenthion depends on one major factor—whether or not the individual organism is in or near the limited area in which the soil drench chemical is applied. Because the area treated with fenthion is small, the majority of individuals in a program area will not be exposed.

For those terrestrial vertebrate species who do feed in, traverse, or inhabit areas treated with fenthion, the primary route of exposure is ingestion, usually of insects killed or incapacitated by the chemical. Both dermal exposure as well as ingestion of contaminated plant material or prey contribute substantially to fenthion dose to insects. Among the various groups of terrestrial organisms, invertebrates and small mammals received the highest doses, whereas the carnivorous birds received the lowest doses (our exposure modeling did not include bioconcentration). Exposure of terrestrial species to fenthion is generally higher in the eastern ecoregions.

Aquatic organisms will have extremely limited exposure to fenthion because it is not used in aquatic areas. Under the extreme scenario, rainfall will wash some fenthion into aquatic areas in two of the six ecoregions from a ditch adjacent to a treated orchard. In the Mississippi Delta and Floridian ecoregions, fish, invertebrates, and other aquatic species could be so exposed to moderate concentrations of fenthion (8.1 to 22.1 μg/L).

(c) Risk Assessment

Fenthion may represent a greater risk to birds than diazinon or chlorpyrifos (table V-10). Other exposed terrestrial species at high risk from fenthion include all reptiles, amphibians, and most terrestrial invertebrates modeled. Fenthion represents a risk to fewer aquatic species than does chlorpyrifos if exposure occurs.

If fenthion were part of a Medfly program, its use could be subject to the same restrictions that apply to diazinon. For fenthion and for all soil drenches, soil fauna in treated soil are at great risk. Actual disturbances and time to return to pre-treatment conditions are site-specific. Although fenthion represents a substantial risk to exposed individuals, the nontarget species populations as a whole are not at risk because of the limited use of soil drenches.

c. Fumigation

(1) Methyl Bromide

(a) Hazard Assessment

Methyl bromide is acutely toxic. Although the mode of action is not well understood, methyl bromide is an alkylating agent, a substance that deactivates enzymes and disrupts nucleic acid synthesis. A NOEL of 0.065 mg/L (17 ppm) was determined for an 8-hour daily inhalation exposure over 6 months for the rabbit, the most sensitive laboratory animal species tested (Alexeeff and Kilgore, 1983). The rat LD_{50} is 2,700 ppm for a 30-minute exposure. The Colorado potato beetle LD_{50} is 1,058 ppm for a 2-hour exposure at 25° C (Bond and Svec, 1977).

Because methyl bromide is heavier than air, the gas can collect in isolated pockets, which could create hazardous conditions when there is little air circulation. Data on the concentrations of methyl bromide in the air outside of a fumigation site are few, and a qualitative risk assessment follows.

(b) Exposure Analysis

The highest concentrations of methyl bromide will occur when the gas is expelled from a fumigation chamber and allowed to disperse into open air. This process is facilitated by fans (capable of blowing 5,000 cubic feet per minute). The majority of the gas will be expelled within the first 5 minutes, but some pockets of gas may be partially trapped and will take longer to dissipate. When expelled, the gas is diluted by the ambient air. Concentrations will be greatest near the source. Standard operating procedures require a 30-ft barrier (about 10 m) around the fumigation site to protect the general public from exposure to unsafe levels of fumigant.

(c) Risk Assessment

Fumigations will have little effect on vertebrate nontarget species because methyl bromide is likely to dilute rapidly outside of the fumigation chamber. Human activity associated with fumigation operations, in addition to the noise and turbulence caused by fans expelling the gas at 5,000 ft^3 per minute during venting, will repel most vertebrate nontarget animals from the vicinity of a fumigation site.

Some gas could penetrate the soil near the vent opening, effectively fumigating the soil and soil invertebrates near the fan. Above-ground arthropods near the source would also be at risk.

Table V-6. Estimates of Mortality to Exposed Individuals from Aerial Application of Malathion[1]

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Mammals						
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	19.5	31.8	26.1	12.5	6.1	9.2
Bat	1.7	4.2	2.8	<1.0	<1.0	<1.0
Cottontail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Squirrel	<1.0	N/A[2]	<1.0	<1.0	<1.0	<1.0
Mouse	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds						
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	<1.0	<1.0	N/A	<1.0	<1.0	<1.0

continued

Table V-6, continued.

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Birds (continued)						
Quail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Killdeer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mourning dove	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0
Northern flicker	<1.0	<1.0	N/A	<1.0	<1.0	<1.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Northern mockingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
European starling	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Reptiles						
Desert iguana	<1.0	<1.0	N/A	N/A	N/A	N/A
Side-blotched lizard	<1.0	<1.0	N/A	N/A	N/A	N/A
Carolina anole	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Eastern fence lizard	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Western fence lizard	<1.0	<1.0	N/A	N/A	N/A	N/A
Canyon lizard	N/A	N/A	<1.0	N/A	N/A	N/A
Terrestrial Reptiles (continued)						
Gopher snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Garter snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Desert tortoise	<1.0	<1.0	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0
Western box turtle	N/A	<1.0	<1.0	<1.0	N/A	N/A
Hognose snake	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Amphibians						
Toad	36.9	52.4	46.2	28.1	15.5	21.8
Tree frog	54.1	68.9	61.6	42.1	27.9	36.0
Terrestrial Invertebrates						
Earthworm	100.0	100.0	100.0	100.0	100.0	100.0
Slug	100.0	100.0	100.0	100.0	100.0	100.0
Sow bug	100.0	100.0	100.0	100.0	100.0	100.0
Spider	91.7	96.3	94.5	81.1	61.6	70.7
Mayfly	100.0	100.0	100.0	100.0	100.0	100.0
Dragonfly	100.0	100.0	100.0	100.0	100.0	100.0
Grasshopper	100.0	100.0	100.0	100.0	100.0	100.0
Lacewing	99.5	99.9	99.8	99.1	97.5	98.7
Water strider	65.6	78.7	73.0	53.1	36.3	45.5

continued

Table V-6, continued.

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Invertebrates						
Beetle, grub	100.0	100.0	100.0	100.0	100.0	100.0
Beetle, adult	91.9	96.0	94.5	88.5	82.4	86.5
Butterfly	20.1	22.8	21.5	18.9	16.7	18.1
Moth	24.5	27.6	26.1	23.0	20.5	22.2
Caterpillar	30.8	33.9	32.4	28.7	25.8	27.5
Maggot	100.0	100.0	100.0	100.0	100.0	100.0
Fly	100.0	100.0	100.0	100.0	100.0	100.0
Ant	100.0	100.0	100.0	100.0	100.0	100.0
Honey bee	100.0	100.0	100.0	100.0	100.0	100.0
Wasp	100.0	100.0	100.0	100.0	100.0	100.0
Fish (Habitat)						
Golden shiner (lake)	40.2	45.5	52.6	45.5	45.2	45.4
Golden shiner (pond)	66.9	18.13	62.8	72.4	71.6	71.9
Speckled dace (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A
Mexican tetra (stream)	N/A	N/A	<1.0	N/A	N/A	N/A
Silvery minnow	N/A	N/A	N/A	<1.0	<1.0	N/A
Goldfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sheepshead minnow (stream)	N/A	N/A	N/A	<1.0	<1.0	<1.0
Sheepshead minnow (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0
California killifish (stream)	<1.0	N/A	N/A	N/A	N/A	N/A
California killifish (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A
Swamp darter	N/A	N/A	N/A	<1.0	<1.0	<1.0
Mosquito fish (stream)	2.6	2.6	2.3	2.6	2.6	2.6
Mosquito fish (pond)	11.7	15.3	9.7	15.2	14.6	<14.8
Rainbow trout (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A
Rainbow trout (lake)	<1.0	N/A	N/A	N/A	N/A	N/A
Arroyo chub (stream)	<1.0	N/A	N/A	N/A	N/A	N/A
Bluegill sunfish (stream)	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Bluegill sunfish (lake)	<1.0	N/A	1.2	<1.0	<1.0	<1.0
Bluegill sunfish (pond)	2.9	4.2	2.3	4.1	3.9	4.0
Largemouth bass (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Largemouth bass (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Channel catfish (stream)	N/A	N/A	<1.0	N/A	<1.0	<1.0
Channel catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0
Yellow bullhead catfish (stream)	N/A	N/A	N/A	<1.0	<1.0	N/A
Yellow bullhead catfish (lake)	N/A	N/A	N/A	N/A	<1.0	N/A
Yellow bullhead catfish (pond)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Longnose gar (lake)	N/A	N/A	<1.0	<1.0	<1.0	5.6
Longnose gar (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Longnose gar (wetland)	N/A	N/A	N/A	N/A	N/A	5.6
Lake chubsucker (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

continued

Table V-6, continued.

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Aquatic Reptiles						
Snapping turtle (wetland)	N/A	N/A	N/A	5.6	5.3	5.4
Western pond turtle (wetland)	4.0	N/A	N/A	N/A	N/A	N/A
Water snake (wetland)	N/A	N/A	N/A	5.6	5.3	5.4
Aquatic Amphibians (larval forms)						
Bullfrog (wetland)	8.2	N/A	N/A	10.9	10.5	10.6
Tiger salamander (wetland)	8.2	N/A	N/A	10.9	10.5	N/A
Amphiuma (wetland)	N/A	N/A	N/A	10.9	10.5	10.6
Aquatic Invertebrates						
Sponge, freshwater (stream)	<1.0	N/A	N/A	<1.0	<1.0	<1.0
Sponge, freshwater (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sponge, freshwater (pond)	1.0	<1.0	<1.0	1.0	<1.0	<1.0
Hydra (wetland)	10.0	N/A	N/A	13.1	12.5	12.7
Leech (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech (pond)	<1.0	1.0	<1.0	<1.0	<1.0	<1.0
Leech (wetland)	10.0	N/A	N/A	13.1	12.6	12.7
Clam, freshwater (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater (stream)	<1.0	<1.0	<1.0	13.1	12.5	12.7
Snail, freshwater (wetland)	10.0	N/A	N/A	<1.0	<1.0	<1.0
Scud (pond)	99.9	99.9	99.8	99.9	99.9	99.9
Crayfish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish (wetland)	10.0	N/A	N/A	13.1	12.6	12.7
Water flea (lake)	98.1	98.7	99.2	98.7	98.6	98.6
Dragonfly, larva (stream)	37.3	37.4	35.8	37.3	37.4	37.5
Dragonfly, larva (pond)	66.9	72.6	62.8	72.4	71.6	71.9
Dragonfly, larva (wetland)	94.9	N/A	N/A	96.2	96.3	96.2
Mayfly, larva (stream)	99.1	<1.0	<1.0	99.1	<1.0	<1.0
Mayfly, larva (lake)	99.3	99.5	99.7	99.5	99.5	99.5
Stonefly, larva (stream)	99.1	<1.0	<1.0	99.1	<1.0	<1.0
Caddis fly, larva (stream)	64.7	<1.0	<1.0	64.6	<1.0	<1.0
Back swimmer (pond)	87.2	90.3	84.8	90.3	89.8	90.0
Back swimmer (wetland)	99.0	N/A	N/A	99.4	99.3	99.3
Beetle (pond)	87.2	90.3	84.8	90.3	89.8	90.0
Mosquito, larva (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva (wetland)	2.0	N/A	N/A	2.9	2.8	2.8

[1]Estimates are based on the routine exposure scenario.
[2]N/A = Not applicable; species does not occur in area.

Table V-7. Estimates of Mortality to Exposed Individuals from Ground Application of Malathion[1]

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Mammals						
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cottontail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Squirrel	<1.0	N/A[2]	<1.0	<1.0	<1.0	<1.0
Mouse	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds						
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	<1.0	<1.0	N/A	<1.0	<1.0	<1.0
Quail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Killdeer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mourning dove	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0
Northern flicker	<1.0	<1.0	N/A	<1.0	<1.0	<1.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Northern mockingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
European starling	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Reptiles						
Desert iguana	<1.0	<1.0	N/A	N/A	N/A	N/A
Side-blotched lizard	<1.0	<1.0	N/A	N/A	N/A	N/A
Carolina anole	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Eastern fence lizard	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Western fence lizard	<1.0	<1.0	N/A	N/A	N/A	N/A
Canyon lizard	N/A	N/A	<1.0	N/A	N/A	N/A
Gopher snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Garter snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Desert tortoise	<1.0	<1.0	N/A	N/A	N/A	N/A

continued

Table V-7, continued.

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Reptiles (continued)						
Eastern box turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0
Western box turtle	N/A	<1.0	<1.0	<1.0	N/A	N/A
Hognose snake	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Amphibians						
Toad	<1.0	<1.0	<1.0	1.3	2.8	2.8
Tree frog	1.7	1.7	1.4	3.0	5.3	5.3
Terrestrial Invertebrates						
Earthworm	100.0	100.0	100.0	100.0	100.0	100.0
Slug	100.0	100.0	100.0	100.0	100.0	100.0
Sow bug	100.0	100.0	100.0	100.0	100.0	100.0
Spider	95.8	95.8	95.8	96.1	96.5	96.5
Mayfly	100.0	100.0	100.0	100.0	100.0	100.0
Dragonfly	100.0	100.0	100.0	100.0	100.0	100.0
Grasshopper	100.0	100.0	100.0	100.0	100.0	100.0
Lacewing	98.6	98.6	98.6	99.7	99.9	99.9
Water strider	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle, grub	100.0	100.0	100.0	100.0	100.0	100.0
Beetle, adult	39.7	39.9	40.0	70.3	85.2	85.1
Butterfly	13.4	13.4	13.4	19.1	23.0	23.0
Moth	17.1	17.1	17.1	23.6	28.0	28.0
Caterpillar	31.3	31.3	31.3	34.6	37.3	37.3
Maggot	100.0	100.0	100.0	100.0	100.0	100.0
Fly	100.0	100.0	100.0	100.0	100.0	100.0
Ant	100.0	100.0	100.0	100.0	100.0	100.0
Honey bee	99.7	100.0	99.7	99.7	99.7	99.7
Wasp	100.0	100.0	100.0	100.0	100.0	100.0
Fish (Habitat)						
Golden shiner (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	2.6	2.6	2.6	8.0	16.0	16.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0
Golden shiner (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Speckled dace (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A
Mexican tetra (stream)	N/A	N/A	<1.0	N/A	N/A	N/A
Silvery minnow (lake)	N/A	N/A	N/A	<1.0	<1.0	N/A
Goldfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sheepshead minnow (stream)	N/A	N/A	N/A	<1.0	<1.0	<1.0
Sheepshead minnow (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0
California killifish (stream)	<1.0	N/A	N/A	N/A	N/A	N/A
California killifish (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A
Swamp darter (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0
Mosquito fish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito fish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Rainbow trout (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A
Rainbow trout (lake)	<1.0	N/A	N/A	N/A	N/A	N/A
Arroyo chub (stream)	<1.0	N/A	N/A	N/A	N/A	N/A
Bluegill sunfish (stream)	N/A	N/A	<1.0	<1.0	<1.0	<1.0

continued

Table V-7, continued.

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Fish (Habitat) (continued)						
Bluegill sunfish (lake)	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Bluegill sunfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Largemouth bass (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Largemouth bass (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Channel catfish (stream)	N/A	N/A	<1.0	N/A	<1.0	<1.0
Channel catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0
Yellow bullhead catfish (stream)	N/A	N/A	N/A	<1.0	<1.0	N/A
Yellow bullhead catfish (lake)	N/A	N/A	N/A	N/A	<1.0	N/A
Yellow bullhead catfish (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Longnose gar (lake)	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Longnose gar (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Longnose gar (wetland)	N/A	N/A	N/A	N/A	N/A	<1.0
Lake chubsucker (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Aquatic Reptiles						
Snapping turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0
Western pond turtle	<1.0	N/A	N/A	N/A	N/A	N/A
Water snake	N/A	N/A	N/A	<1.0	<1.0	<1.0
Aquatic Amphibians (larval forms)						
Bullfrog	<1.0	N/A	N/A	<1.0	<1.0	<1.0
Tiger salamander	<1.0	N/A	N/A	<1.0	<1.0	N/A
Amphiuma	N/A	N/A	N/A	<1.0	<1.0	<1.0
Aquatic Invertebrates						
Sponge, freshwater	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hydra	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Clam, freshwater	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Scud	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Water flea	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, juvenile	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mayfly, larva	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Stonefly, larva	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caddis fly, juvenile	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Back swimmer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

[1]Based on extreme scenario; no exposure anticipated under routine scenario.
[2]N/A = Not applicable; species does not occur in area.

Table V-8. Estimates of Mortality to Exposed Individuals from Diazinon Soil Treatment[1]

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Mammals						
Opossum	9.5	11.3	9.9	10.5	15.2	11.8
Shrew	99.8	99.9	99.8	100.0	100.0	100.0
Bat	48.7	48.7	48.7	75.0	87.4	87.4
Cottontail	15.4	15.4	13.0	13.0	13.0	13.0
Squirrel	49.6	N/A[2]	49.6	61.4	70.4	70.4
Mouse	80.1	81.2	80.3	76.7	85.1	77.6
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds						
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	2.9	2.9	2.9	3.6	4.6	4.6
American kestrel	100.0	100.0	N/A	100.0	100.0	100.0
Quail	100.0	100.0	100.0	100.0	100.0	100.0
Killdeer	100.0	100.0	100.0	100.0	100.0	100.0
Mourning dove	100.0	100.0	100.0	100.0	100.0	100.0
Great horned owl	7.5	7.3	7.7	6.9	18.0	7.1
Killdeer	66.9	66.9	66.9	66.9	66.9	66.9
Mourning dove	36.8	36.8	36.8	36.8	36.8	36.8
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Northern flicker	100.0	100.0	N/A	100.0	100.0	100.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	59.6	62.8	60.4	62.7	<1.0	65.8
Northern mockingbird	64.1	64.1	64.1	67.4	68.6	70.3
European starling	62.8	62.8	74.5	68.2	72.6	72.6
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	100.0	100.0	100.0	100.0	100.0	100.0
Terrestrial Reptiles						
Desert iguana	43.9	44.0	N/A	N/A	N/A	N/A
Side-blotched lizard	94.7	94.7	N/A	N/A	N/A	N/A
Carolina anole	N/A	N/A	94.8	96.4	97.5	97.5
Eastern fence lizard	N/A	N/A	92.4	94.8	96.6	96.3
Western fence lizard	90.5	91.2	N/A	N/A	N/A	N/A
Canyon lizard	N/A	N/A	94.4	N/A	N/A	N/A
Gopher snake	10.4	11.4	10.1	9.4	9.5	9.5
Garter snake	27.5	27.5	27.5	29.4	31.2	31.2

continued

Table V-8, continued.

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Reptiles (continued)						
Desert tortoise	11.7	10.5	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	73.2	79.6	77.1
Western box turtle	N/A	74.2	74.2	81.8	N/A	N/A
Hognose snake	N/A	63.0	62.8	62.7	63.1	62.8
Terrestrial Amphibians						
Toad	5.1	5.5	5.8	6.3	7.4	6.8
Tree frog	3.8	3.8	3.2	4.1	5.0	5.0
Terrestrial Invertebrates						
Earthworm	100.0	100.0	100.0	100.0	100.0	100.0
Slug	100.0	100.0	100.0	100.0	100.0	100.0
Sow bug	100.0	100.0	100.0	100.0	100.0	100.0
Spider	100.0	100.0	100.0	100.0	100.0	100.0
Mayfly	100.0	100.0	100.0	100.0	100.0	100.0
Dragonfly	100.0	100.0	100.0	100.0	100.0	100.0
Grasshopper	100.0	100.0	100.0	100.0	100.0	100.0
Lacewing	100.0	100.0	100.0	100.0	100.0	100.0
Water strider	<1.0	<1.0	<1.0	3.2	7.5	7.5
Beetle, grub	100.0	100.0	100.0	100.0	100.0	100.0
Beetle, adult	100.0	100.0	100.0	100.0	100.0	100.0
Butterfly	100.0	100.0	100.0	100.0	100.0	100.0
Moth	100.0	100.0	100.0	100.0	100.0	100.0
Caterpillar	100.0	100.0	100.0	100.0	100.0	100.0
Maggot	100.0	100.0	100.0	100.0	100.0	100.0
Fly	100.0	100.0	100.0	100.0	100.0	100.0
Ant	100.0	100.0	100.0	100.0	100.0	100.0
Honey bee	100.0	100.0	100.0	100.0	100.0	100.0
Wasp	100.0	100.0	100.0	100.0	100.0	100.0
Fish						
Mosquito fish	<1.0	<1.0	<1.0	<1.0	0.0	0.0
Aquatic Reptiles						
Snapping turtle	<1.0	<1.0	<1.0	<1.0	27.6	0.0
Water snake	<1.0	<1.0	<1.0	<1.0	27.6	0.0
Aquatic Amphibians (larval forms)						
Bullfrog	<1.0	<1.0	<1.0	<1.0	27.6	0.0
Tiger salamander	<1.0	<1.0	<1.0	<1.0	27.6	0.0
Amphiuma	<1.0	<1.0	<1.0	<1.0	27.6	0.0
Aquatic Invertebrates						
Leech	<1.0	<1.0	<1.0	<1.0	99.7	1.8
Snail, freshwater	<1.0	<1.0	<1.0	<1.0	99.7	1.8
Crayfish	<1.0	<1.0	<1.0	<1.0	100.0	24.2
Dragonfly, larva	<1.0	<1.0	<1.0	<1.0	23.4	0.0
Mosquito, larva	<1.0	<1.0	<1.0	<1.0	23.4	0.0

[1] Based on extreme scenario; no exposure anticipated under routine scenario.
[2] N/A = Not applicable; species does not occur in area.

Table V-9. Estimates of Mortality to Exposed Individuals from Chlorpyrifos Soil Treatment[1]

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Mammals						
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	98.2	98.5	98.6	99.1	99.6	99.5
Bat	<1.0	<1.0	<1.0	11.1	22.6	22.6
Cottontail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Squirrel	<1.0	N/A[2]	<1.0	<1.0	<1.0	<1.0
Mouse	32.0	33.3	34.1	34.1	45.5	39.9
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds						
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	70.6	70.6	N/A	71.8	73.0	73.0
Quail	7.5	12.5	31.4	32.5	33.5	33.5
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	20.8	20.8	20.8	32.9	43.8	43.8
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0
Northern flicker	37.1	37.1	N/A	41.7	46.0	45.9
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	98.9	99.0	99.1	99.0	99.2	99.1
Northern mockingbird	96.3	96.3	96.3	96.8	97.2	97.2
European starling	96.8	96.8	96.8	97.4	97.8	97.8
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	94.3	94.3	94.3	95.9	97.0	97.0
Terrestrial Reptiles						
Desert iguana	65.2	65.3	N/A	N/A	N/A	N/A
Side-blotched lizard	98.6	98.6	N/A	N/A	N/A	N/A
Carolina anole	N/A	N/A	98.5	99.2	99.5	99.5
Eastern fence lizard	N/A	N/A	99.4	99.7	99.9	99.8
Western fence lizard	99.1	99.2	N/A	N/A	N/A	N/A
Canyon lizard	N/A	N/A	98.5	N/A	N/A	N/A
Gopher snake	13.3	18.3	13.6	6.0	6.3	6.2
Garter snake	24.3	24.4	24.4	26.6	28.8	28.8
Desert tortoise	29.5	29.5	N/A	N/A	N/A	N/A

continued

Table V-9, continued.

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Reptiles (continued)						
Eastern box turtle	N/A	N/A	N/A	97.4	98.2	97.9
Western box turtle	N/A	83.3	83.3	89.9	N/A	N/A
Hognose snake	N/A	73.8	74.2	73.4	74.3	73.7
Terrestrial Amphibians						
Toad	12.3	13.0	14.4	13.8	15.9	14.9
Tree frog	3.9	3.9	3.2	4.1	5.1	5.1
Terrestrial Invertebrates						
Earthworm	100.0	100.0	100.0	100.0	100.0	100.0
Slug	100.0	100.0	100.0	100.0	100.0	100.0
Sow bug	100.0	100.0	100.0	100.0	100.0	100.0
Spider	97.4	97.4	97.4	97.6	97.8	97.8
Mayfly	98.7	98.7	98.7	99.4	99.6	99.6
Dragonfly	94.5	94.5	94.5	93.2	95.2	95.2
Grasshopper	100.0	100.0	100.0	100.0	100.0	100.0
Lacewing	99.8	99.8	99.8	99.9	99.9	99.9
Water strider	34.8	34.8	34.8	39.4	42.9	42.9
Beetle, grub	98.6	98.6	98.6	98.9	99.1	99.1
Beetle, adult	98.2	98.3	98.3	98.7	99.0	99.0
Butterfly	100.0	100.0	100.0	100.0	100.0	100.0
Moth	100.0	100.0	100.0	100.0	100.0	100.0
Caterpillar	100.0	100.0	100.0	100.0	100.0	100.0
Maggot	100.0	100.0	100.0	100.0	100.0	100.0
Fly	100.0	100.0	100.0	100.0	100.0	100.0
Ant	100.0	100.0	100.0	100.0	100.0	100.0
Honey bee	100.0	100.0	100.0	100.0	100.0	100.0
Wasp	100.0	100.0	100.0	100.0	100.0	100.0
Fish						
Mosquito fish	<1.0	<1.0	<1.0	<1.0	60.9	41.4
Aquatic Reptiles						
Snapping turtle	<1.0	<1.0	<1.0	<1.0	100.0	100.0
Water snake	<1.0	<1.0	<1.0	<1.0	100.0	100.0
Aquatic Amphibians (larval forms)						
Tiger salamander	<1.0	<1.0	<1.0	<1.0	100.0	100.0
Amphiuma	<1.0	<1.0	<1.0	<1.0	100.0	100.0
Aquatic Invertebrates						
Leech	<1.0	<1.0	<1.0	<1.0	100.0	100.0
Snail, freshwater	<1.0	<1.0	<1.0	<1.0	100.0	100.0
Crayfish	<1.0	<1.0	<1.0	<1.0	100.0	100.0
Dragonfly, larva	<1.0	<1.0	<1.0	<1.0	100.0	100.0
Mosquito, larva	<1.0	<1.0	<1.0	<1.0	100.0	100.0

[1]Based on extreme scenario; no exposure anticipated under routine scenario.
[2]N/A = Not applicable; species does not occur in area.

Table V-10. **Estimates of Mortality to Exposed Individuals from Fenthion Soil Treatment**[1]

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Mammals						
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	83.0	87.6	83.3	91.8	96.9	95.8
Bat	<1.0	<1.0	<1.0	6.7	15.2	15.2
Cottontail	91.5	91.5	90.6	90.6	90.6	90.6
Squirrel	<1.0	N/A[2]	<1.0	<1.0	<1.0	<1.0
Mouse	11.9	13.7	12.0	10.2	16.9	11.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds						
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds (continued)						
Red-tailed hawk	2.6	2.6	2.6	2.9	4.0	4.0
American kestrel	99.9	100.0	N/A	100.0	100.0	100.0
Quail	76.9	76.8	96.8	97.0	97.1	97.1
Killdeer	99.8	99.8	99.8	99.8	99.8	99.8
Mourning dove	99.3	99.3	99.3	99.3	99.3	99.3
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	96.0	96.0	96.0	98.2	99.1	99.1
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0
Northern flicker	97.8	97.8	N/A	98.4	98.7	98.7
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	98.7	99.0	98.7	98.9	99.3	99.0
Northern mockingbird	98.8	98.8	98.8	98.9	99.1	99.1
European starling	98.9	98.9	98.9	99.1	99.3	99.3
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	91.0	91.0	91.0	93.2	94.7	94.7
Terrestrial Reptiles						
Desert iguana	99.7	99.7	N/A	N/A	N/A	N/A
Side-blotched lizard	100.0	100.0	N/A	N/A	N/A	N/A
Carolina anole	N/A	N/A	100.0	100.0	100.0	100.0
Eastern fence lizard	N/A	N/A	100.0	100.0	100.0	100.0
Western fence lizard	100.0	100.0	N/A	N/A	N/A	N/A
Canyon lizard	N/A	N/A	100.0	N/A	N/A	N/A
Gopher snake	91.6	93.9	91.6	84.8	85.2	84.9
Garter snake	96.5	96.5	96.5	96.9	97.3	97.3
Desert tortoise	97.4	97.4	N/A	N/A	N/A	N/A

continued

Table V-10, continued.

Species	Eco-region 1	Eco-region 2	Eco-region 3	Eco-region 4	Eco-region 5	Eco-region 6
Terrestrial Reptiles (continued)						
Eastern box turtle	N/A	N/A	N/A	100.0	100.0	100.0
Western box turtle	N/A	99.9	99.9	100.0	N/A	N/A
Hognose snake	N/A	99.8	99.8	99.8	99.8	99.8
Terrestrial Amphibians						
Toad	100.0	100.0	100.0	100.0	100.0	100.0
Tree frog	100.0	100.0	100.0	100.0	100.0	100.0
Terrestrial Invertebrates						
Earthworm	100.0	100.0	100.0	100.0	100.0	100.0
Slug	100.0	100.0	100.0	100.0	100.0	100.0
Sow bug	100.0	100.0	100.0	100.0	100.0	100.0
Spider	100.0	100.0	100.0	100.0	100.0	100.0
Mayfly	100.0	100.0	100.0	100.0	100.0	100.0
Dragonfly	100.0	100.0	100.0	100.0	100.0	100.0
Grasshopper	100.0	100.0	100.0	100.0	100.0	100.0
Lacewing	100.0	100.0	100.0	100.0	100.0	100.0
Water strider	32.5	32.5	32.5	52.8	67.6	67.6
Beetle, grub	100.0	100.0	100.0	100.0	100.0	100.0
Beetle, adult	100.0	100.0	100.0	100.0	100.0	100.0
Butterfly	100.0	100.0	100.0	100.0	100.0	100.0
Moth	100.0	100.0	100.0	100.0	100.0	100.0
Caterpillar	100.0	100.0	100.0	100.0	100.0	100.0
Maggot	100.0	100.0	100.0	100.0	100.0	100.0
Fly	100.0	100.0	100.0	100.0	100.0	100.0
Ant	100.0	100.0	100.0	100.0	100.0	100.0
Honey bee	100.0	100.0	100.0	100.0	100.0	100.0
Wasp	100.0	100.0	100.0	100.0	100.0	100.0
Fish						
Mosquito fish	<1.0	<1.0	<1.0	<1.0	1.1	0.0
Aquatic Reptiles						
Snapping turtle	<1.0	<1.0	<1.0	<1.0	0.0	0.0
Water snake	<1.0	<1.0	<1.0	<1.0	0.0	0.0
Aquatic Amphibians (larval forms)						
Tiger salamander	<1.0	<1.0	<1.0	<1.0	<1.0	0.0
Amphiuma	<1.0	<1.0	<1.0	<1.0	<1.0	0.0
Aquatic Invertebrates						
Leech	<1.0	<1.0	<1.0	<1.0	83.6	48.5
Snail, freshwater	<1.0	<1.0	<1.0	<1.0	83.6	48.5
Crayfish	<1.0	<1.0	<1.0	<1.0	20.5	3.3
Dragonfly, larva	<1.0	<1.0	<1.0	<1.0	94.6	72.4
Mosquito, larva	<1.0	<1.0	<1.0	<1.0	94.6	72.4

[1]Based on extreme scenario; no exposure anticipated under routine scenario.
[2]N/A = Not applicable; species does not occur in area.

Table V-11. Summary of Comparative Risks to Exposed Individuals[1] from Program Chemicals[2]

Species	Aerial Malathion	Ground Malathion	Diazinon	Chlorpyrifos	Fenthion
Terrestrial Mammals					
Opossum	–	–	+	–	–
Shrew	+	–	+ +	+ +	+
Bat	+	–	+	+	+
Cottontail	–	–	+	–	+
Squirrel	–	–	+	–	–
Mouse	–	–	+	+	+
Raccoon	–	–	–	–	–
Fox	–	–	–	–	–
Coyote/Dog	–	–	–	–	–
Cat	–	–	–	–	–
Deer	–	–	–	–	–
Terrestrial Birds					
Pied–billed grebe	–	–	–	–	–
Great blue heron	–	–	–	–	–
Cattle egret	–	–	–	–	–
Duck	–	–	–	–	–
Turkey vulture	–	–	–	–	–
Red–tailed hawk	–	–	+	–	+
American kestrel	–	–	+ +	+	+ +
Quail	–	–	+ +	+	+
Killdeer	–	–	+ +	+	+ +
Mourning dove	–	–	+ +	+	+ +
Great horned owl	–	–	+	–	–
Burrowing owl	–	–	–	–	–
Nighthawk	–	–	–	–	–
Hummingbird	–	–	+	+	+ +
Belted kingfisher	–	–	–	–	–
Northern flicker	–	–	+ +	+	+
Kingbird	–	–	–	–	–
American robin	–	–	+	+ +	+ +
Northern mockingbird	–	–	+	+	+ +
European starling	–	–	+	+	+ +
Red–winged blackbird	–	–	–	–	–
Meadowlark	–	–	–	–	–
House sparrow	–	–	+ +	+	+
Terrestrial Reptiles					
Desert iguana	–	–	+	+	+ +
Side–blotched lizard	–	–	+	+	+ +
Carolina anole	–	–	+	+ +	+ +
Eastern fence lizard	–	–	+	+ +	+ +
Western fence lizard	–	–	+	+ +	+ +
Canyon lizard	–	–	+	+	+ +
Gopher snake	–	–	+	+	+
Garter snake	–	–	+	+	+
Desert tortoise	–	–	+	+	+
Eastern box turtle	–	–	+	+	+ +

continued

Table V-11, continued.

Species	Aerial Malathion	Ground Malathion	Diazinon	Chlorpyrifos	Fenthion
Terrestrial Reptiles (continued)					
Western box turtle	–	–	+	+	+ +
Hognose snake	–	–	+	+	+ +
Terrestrial Amphibians					
Toad	+	+	+	+	+ +
Tree frog	+	+	+	+	+ +
Terrestrial Invertebrates					
Earthworm	+ +	+ +	+ +	+ +	+ +
Slug	+ +	+ +	+ +	+ +	+ +
Sow bug	+ +	+ +	+ +	+ +	+ +
Spider	+	+	+ +	+ +	+ +
Mayfly	+ +	+ +	+ +	+ +	+ +
Dragonfly	+ +	+ +	+ +	+	+ +
Grasshopper	+ +	+ +	+ +	+ +	+ +
Lacewing	+ +	+ +	+ +	+ +	+ +
Water strider	+	–	+	+	+
Beetle, grub	+ +	+ +	+ +	+ +	+ +
Beetle, adult	+	+	+ +	+ +	+ +
Butterfly	+	+	+ +	+ +	+ +
Moth	+	+	+ +	+ +	+ +
Caterpillar	+	+	+ +	+ +	+ +
Maggot	+ +	+ +	+ +	+ +	+ +
Fly	+ +	+ +	+ +	+ +	+ +
Ant	+ +	+ +	+ +	+ +	+ +
Honey bee	+ +	+ +	+ +	+ +	+ +
Wasp	+ +	+ +	+ +	+ +	+ +
Fish					
Golden shiner	+	–	N/A[2]	N/A	N/A
Speckled dace	–	–	N/A	N/A	N/A
Mexican tetra	–	–	N/A	N/A	N/A
Silvery minnow	–	–	N/A	N/A	N/A
Goldfish	–	–	N/A	N/A	N/A
Sheepshead minnow	–	–	N/A	N/A	N/A
California killifish	–	–	N/A	N/A	N/A
Swamp darter	–	–	N/A	N/A	N/A
Mosquito fish	+	–	–	+	+
Rainbow trout	–	–	N/A	N/A	N/A
Arroyo chub	–	–	N/A	N/A	N/A
Bluegill sunfish	+	–	N/A	N/A	N/A
Largemouth bass	–	–	N/A	N/A	N/A
Channel catfish	–	–	N/A	N/A	N/A
Yellow bullhead catfish	–	–	N/A	N/A	N/A
Longnose gar	+	–	N/A	N/A	N/A
Lake chubsucker	–	–	N/A	N/A	N/A
Aquatic Reptiles					
Snapping turtle	+	–	+	+ +	–
Western pond turtle	+	–	N/A	N/A	N/A
Water snake	+	–	+	+ +	–

continued

Table V-11, continued.

Species	Aerial Malathion	Ground Malathion	Diazinon	Chlorpyrifos	Fenthion
Aquatic Amphibians (larval forms)					
Bullfrog	+	–	+	+ +	–
Tiger salamander	+	–	+	+ +	–
Amphiuma	+	–	+	+ +	–
Aquatic Invertebrates					
Sponge, freshwater	–	–	N/A	N/A	N/A
Hydra	+	–	N/A	N/A	N/A
Leech	+	–	+ +	+ +	+
Clam, freshwater	–	–	N/A	N/A	N/A
Snail, freshwater	+	–	+ +	+ +	+
Scud	+ +	–	N/A	N/A	N/A
Crayfish	+	–	+ +	+ +	+
Water flea	+ +	–	N/A	N/A	N/A
Dragonfly, larva	+	–	+	+ +	+
Mayfly, larva	+ +	–	N/A	N/A	N/A
Stonefly, larva	+ +	–	N/A	N/A	N/A
Caddis fly, juvenile	+	–	N/A	N/A	N/A
Back swimmer	+ +	–	N/A	N/A	N/A
Beetle	+	–	N/A	N/A	N/A
Mosquito, larva	+	–	+	+ +	+

[1]Exposure based on routine multipathway exposure scenario for malathion.
[2]N/A = Not applicable; program chemicals are not applied to these species habitats.
- Indicates <1% mortality to exposed individuals.
+ Indicates 1% to 99% mortality to exposed individuals.
+ + Indicates ≥99% mortality to exposed individuals.

2. Nonchemical Control Methods

This section qualitatively considers the potential effects of the nonchemical treatment methods.

a. Sterile Insect Technique

The release of sterile Medflies in agricultural and urban areas is unlikely to cause disturbance to domestic animal species. The noise and interruption from aircraft or vehicles dispensing sterile Medflies should not interfere with animal or agricultural production, but could interfere with some sensitive native species or life stages, e.g., nesting birds. Any possible disruption should be transitory with no long term consequences because it is anticipated that most program areas already will be disturbed by human activity.

The sterile Medflies will feed and oviposit on host fruit, however, and will serve as a food source for insectivorous species. No extensive damage to wild host plants is anticipated from the introduced Medflies.

With the addition of the exotic Medflies to a localized invertebrate fauna, a possibility exists for food competition with other fruit fly species and shifts in predator food selection. Because the Medflies will not reproduce, the population will be short-lived and any such changes will be of short duration. The exception would be in the case of the release of nonsterile Medflies. If fertile

flies were inadvertently released and a population became established, the consequences would be far ranging.

b. Physical Control

Domestic animals could be affected when personnel enter a property to strip fruit or eliminate host plants if the animals are agitated by the presence of strangers. Host plant removal could also affect domestic animals by reducing the amount of cover available to provide shelter on rangeland, or by increasing the amount of weedy species unsuitable for forage which would exploit the disturbed environment where trees and shrubs had been removed.

Domestic plants will not be affected by fruit stripping unless the stripping procedure also removes a portion of the vegetative material which reduces the plant's growth rate. Removal of vegetative material could also expose portions of the branch or trunk of woody plants, allowing the entry of bacteria, fungi, or plant pests.

Wild animals that utilize Medfly host fruit as an energy source would be affected by both fruit stripping and host plant removal. These organisms would have to find an alternative source of food and might have to spend more time foraging. However, the ultimate effect of fruit stripping in a control program would be the preservation of the quality and quantity of the host fruit in the area, which would tend to benefit those species in the long run. Larger soil organisms (e.g., burrowing rodents, moles, earthworms, and insects) may be injured or killed during destruction operations, or populations may be reduced as a result of disturbed soil conditions.

Wildlife that use Medfly hosts for shelter would be displaced and would need to locate other trees or shrubs in which to live. Host elimination over a large area would change the plant species in the area by creating patches of disturbed soil and would increase soil erosion, which increases turbidity in aquatic resources. Changes in the plant species in an area could affect animals dependent upon specific types of plants for food or shelter. Increased turbidity in aquatic resources could affect the ability of aquatic organisms to breathe and to find food.

Plants would be affected by fruit stripping due to loss of reproduction for the year. Host elimination would create patches of disturbed soil which could be exploited by weedy, herbaceous plants.

c. Cultural Control

Domestic plants, such as agricultural crops, may be affected by cultural control if crops are grown at different times of the season than usual. This could affect the growth rate of these crops. Domestic animals are not expected to be affected by cultural control.

Cultural control methods, such as clean culture methods, which involve fruit stripping and host plant removal would have the same consequences as those discussed above in the section on Physical Control. Growing Medfly host crops

at special times and using resistant varieties would not affect wild animals and plants. Trap cropping would increase the number of Medflies and Medfly predators in an area and would cause increased mortality to Medfly predators when chemical treatments are used to destroy Medflies. The consequences of chemical treatments are discussed in the chemical control section.

d. Biological Control

In general, domestic animals are unlikely to be affected by biocontrol agents. Predatory and parasitic invertebrate biocontrol agents for Medfly generally affect only other invertebrates, and micro-organisms used for biocontrol (e.g., Bt, NPV) are known to have essentially no negative impacts on domestic animals. Individual honey bees could potentially be at risk from some predators, but hives or colonies should not be considered at risk. Although honey bees are at risk from some parasitic invertebrates (i.e., mites), none of these have been considered as Medfly biocontrol agents. Honey bees are at lower risk from most parasites than are most insects because of their colony structure and defense.

The primary risk to domestic plants is a disruption of pollination systems by predators and parasites that might be used for biocontrol of Medfly. Most agricultural pollination depends on honey bees which are not considered to be at high risk from Medfly biocontrol agents. However, some agricultural pollination and pollination of most other plants (e.g., horticultural plantings) depend on the activities of feral honey bees and other species of insect pollinators. These pollination systems would be disrupted to the extent that predators and parasites released for Medfly control affect populations of natural pollinators. Few data on such complex systems exist for any natural systems; the effect that inundative releases of biocontrol agents for Medfly control would have on pollination systems in program areas is unknown.

If they were available for use, release of biocontrol agents for Medfly control could negatively impact populations of nontarget wild animals (primarily insects) and plants. Predators (including nematodes) probably would not be specific to Medfly and could potentially damage populations of many species of nontarget insects. Parasites would be more specific but could damage populations of insects related to Medfly (e.g., other species of flies). Biological insecticides (Bt and viruses) could affect other species of insects but would be about as specific as parasites. Although these agents could potentially have a serious impact on local nontarget populations, specific impacts are unknown.

e. Biotechnological Control

Although no biotechnological control methods are currently available, one potential biotechnological method for Medfly control is bioengineering of domestic plants (i.e., use of bioengineered (transgenic) citrus trees that resist Medflies). A concern with use of any transgenic organism is exchange of genetic material with nontarget organisms. However, before transgenic plants are released, their ability to exchange genetic material with native, feral, and

weedy species in general is examined closely and steps are taken to avoid exchange of genetic material through specific steps, such as removal of flowers, bagging of flowers, or production of sterile transgenics. It is, therefore, unlikely that transgenic domestic plants could affect nontarget domestic plants because specific steps are taken to prevent exchange of genetic material.

Production and release of combi-flies (genetically altered Medflies), another possible biotechnological control method, would be unlikely to have any direct impact on domestic nontargets. Impacts could potentially result from facilities for production of large quantities of combi-flies and release of large quantities of prey items (combi-flies) for predators (see sterile insect technique).

Another potential method would be the use of genetically engineered micro-organisms. Release of genetically improved micro-organisms for Medfly control could affect nontarget invertebrates to the extent that the biological insecticides kill species other than Medflies. Because most biological insecticides are not species-specific, at least some other related species could be at serious risk. Species at greatest risk would be species closely related to Medfly.

Biotechnological applications that could be developed for Medfly control (see chapter III) would be unlikely to impact domestic animals and plants because there is little opportunity for interaction among bioengineered agents of Medfly control and domestic species. Potential effects on native flora and fauna are unknown at present.

In conclusion, although current regulatory controls and practices would make it unlikely that biotechnological controls would have more than a minimal impact on nontarget biological resources, the uncertainties surrounding the use of this technology for Medfly control have resulted in a determination that its effects are largely unknown.

f. Male Annihilation

The sticky, brightly colored panels used for the purpose of attracting and entrapping Medflies should pose little threat to domestic plants and animals. The surface is coated with a sticky substance and a chemical Medfly lure, both of which pose a negligible toxicologic risk to nontargets. Domestic animals could be attracted to panels that have accidentally dropped to the ground. However, the sticky surface of the panels should deter most animals from chewing them or carrying them away.

The panels are placed out of reach of the public, mostly in trees. The actions of placing these panels should have negligible impact on the trees themselves. Repeated visits to the panels for servicing and replacement could have a negative cumulative effect.

Tests indicate that few nontarget arthropods are attracted to the panels. Other animals should not be affected by the panels themselves. Some disturbance to tree-nesting birds could occur if panels are placed nearby. The probability of

this happening would seem low, but at densities of 1,000 panels per square mile, this scenario is not unreasonable.

3. Combined Control Methods

This section qualitatively considers potential environmental consequences of combined control methods on biological resources. Combined control methods may employ chemical and/or nonchemical control methods, depending upon the alternative.

a. Regulatory Control

Domestic plant species that are potential Medfly hosts will be affected by the quarantine restrictions of regulatory control. The fruits of domestic host plants (backyard and ornamental fruits such as citrus) may spoil if they are intended for sale but cannot be moved out of a quarantine area; they may be destroyed if confiscated at checkpoints; or, they may be treated with methyl bromide, cold temperatures, vapor heat, or hot water before being moved outside the quarantine area. Nursery stock within the quarantine area may be stripped of fruit and treated with malathion bait spray or diazinon soil drench before being moved outside the quarantine area. None of these procedures will have an adverse effect on the domestic plants (see separate chapters for a discussion of the impacts of methyl bromide, malathion, and diazinon).

Domestic and wild animals and plants may be affected by the increased noise and air pollution that could result from cars and trucks idling at quarantine checkpoints, or by increased activity at disposal sites receiving host material. However, any adverse affects will be localized.

b. Integrated Pest Management

Integrated pest management would involve use of any or a combination of controls, as discussed in chapter III, Alternatives. Potential consequences of each of the component control methods have been analyzed separately and would be applicable to integrated pest management.

Cumulative effects may result from combined use of control methods in integrated pest management; these effects would be additive in nature. Cumulative effects may involve: loss of general plant health as a result of combined chemical, cultural, and physical control methods; losses to invertebrate populations from combined controls; effects on plant reproduction due to losses of invertebrate pollinators; and minor risk to wildlife and plants due to community and trophic impacts resulting from combined controls.

In addition, some additional effects may result if homeowners and farmers are required to use pesticides to control or eliminate Medfly on their lands, because an integrated pest management program did not target their lands or was ineffective in controlling Medfly.

Should biological control or biotechnological control technologies be perfected to the point where they can be effectively exploited in a program, they would add to the program's overall risk. They may result in additional consequences,

including further losses in invertebrate populations and further effects on plant reproduction resulting from losses of pollinator species from biocontrol predators or genetically engineered biological insecticides.

4. Habitats or Ecological Associations of Concern

The analysis gave special consideration to habitats or ecological associations of concern. These habitats or ecological associations are important in that they: (1) are unique and valuable resources, (2) serve as indicators of environmental quality, (3) are being diminished through human exploitation, and (4) may be the subject of special regulations and conservation initiatives. This section considers the potential effects of the control methods on habitats or ecological associations of concern.

a. Chemical Control Methods

(1) Bait Spray

Shallow aquatic habitats, such as wetlands, are of concern for the malathion bait spray treatments. Small shallow ponds, ditches, and canals prevalent in some of the ecoregions could receive high concentrations of malathion (e.g., an estimated 59.17 µg/L in southeastern wetlands) if they are located within a treatment area. Loss of invertebrates and fish from these habitats would affect the many organisms dependent upon these fish and invertebrate species for food. Acidic water habitats, such as saltwater marshes, are of particular concern because malathion does not degrade as rapidly in acidic waters as in alkaline waters, and could affect the habitat for a longer period of time. Migratory bird refuges, where large concentrations of birds could be expected to consume invertebrates, are also of concern.

Terrestrial habitats of concern include scrub, South Florida rockland forests, and riparian areas because of the high concentrations of invertebrates and species depending on invertebrates for pollination or food.

(2) Soil Treatments

The three soil drench chemicals—diazinon, chlorpyrifos, and fenthion—have the potential to affect sensitive areas because of the toxicity of these chemicals to a number of nontarget species. However, these chemicals are used only in limited areas and are not very mobile in the environment. Therefore, a sensitive area would only be affected in the unlikely event of a soil drench chemical being applied to that area.

(3) Fumigation

Fumigations associated with the Medfly program are normally conducted where commodities are gathered or stored. These areas are usually removed from sensitive habitats and thus will pose no risk to these habitats.

b. Nonchemical Control Methods

(1) Sterile Insect Technique

The release of sterile Medflies should cause little disruption to plant or vertebrate animal communities. The addition of large numbers of Medflies should also cause little disruption to the insect community; any population composition changes are likely to be of short duration. Debris from the releases could be a visual disturbance, but is unlikely to cause problems in sensitive habitats because the containers biodegrade. Noise from the vehicles or aircraft dispensing the flies could disrupt sensitive nesting birds, but a single disturbance is unlikely to have major consequences.

(2) Physical Control

Host elimination could affect sensitive habitats such as tropical tree hammocks and areas adjacent to the Everglades if host removal were required in such areas.

(3) Cultural Control

Because cultural control would be restricted to agricultural areas and not natural ecosystems, it is not likely that any habitat or ecological association of concern will be affected.

(4) Biological Control

Damage caused by biological control agents for Medfly control would be limited to invertebrate prey items, hosts of insect parasites, and organisms susceptible to insecticidal micro-organisms. Habitats per se would probably not be at risk, but ecological associations could be at risk to the extent that trophic interactions or pollination systems are disrupted. It is unlikely that any species critical to the structure of ecological communities would be at serious risk (see Biodiversity subsection), but precise effects are not known.

(5) Biotechnological Control

Effects of biotechnological methods for Medfly control are specifically designed to impact either agricultural crops or insects. As such, habitats are not at risk. However, as with biocontrol agents, biotechnological agents place ecological associations at risk to the extent that they disrupt community structure.

(6) Male Annihilation

It is unlikely that the sticky boards associated with this technique would be used in sensitive areas or habitats containing unique ecological associations. If it were to occur, sensitive invertebrate species which could be attracted to the boards may be affected. In addition, sensitive nesting birds could avoid trees with the boards or be disturbed by activity associated with the them. Repeated visits for servicing the panels could disturb sensitive plant communities were male annihilation necessary in the immediate vicinity of such habitats.

c. Combined Control Methods

(1) Regulatory Control

Unless quarantine checkpoints or host disposal areas are located immediately adjacent to sensitive areas, regulatory control will have no affect on habitats or ecological associations of concern. If quarantine checkpoints or host disposal areas are located adjacent to sensitive areas, disturbance from normal traffic and disposal operations will be increased. If the magnitude of this increase is great, sensitive areas could be adversely affected (see separate sections for a discussion of the impacts of methyl bromide, malathion, and diazinon).

(2) Integrated Pest Management

Potential effects of the components of integrated pest management have been analyzed separately. Cumulatively, integrated pest management is not likely to have a major effect on any habitats or ecological associations of concern, principally because it considers site-specific characteristics of an area in the selection of component control methods. Some community and trophic effects may result from reductions of invertebrate populations or losses of plant material from habitats, but those effects are expected to be minimal.

5. Endangered and Threatened Species

The Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. 1531 *et seq.*), mandates the protection of endangered and threatened (E&T) species from any Federal, state, or private action that may threaten or impair the species' continued existence. The objectives of ESA are to provide mechanisms for conservation of proposed or formally listed E&T species and the habitats they depend on and to achieve the goals of international treaties and conventions related to the conservation of fish, wildlife, and plants. Under ESA, the Secretary of the Interior or Commerce is required to determine which species are endangered or threatened and to issue regulations to protect those species.

Section 7 of ESA requires Federal agencies to consult with the U.S. Department of the Interior's Fish and Wildlife Service (FWS) or the U.S. Department of Commerce's National Marine Fisheries Service (NMFS) to ensure that any action that they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of its critical habitat (16 U.S.C. 1536(a)(2)). In addition, the act requires that if species proposed for listing or critical habitat proposed for designation are likely to be jeopardized, destroyed, or adversely modified, respectively, a conference must be held with FWS or NMFS.

The E&T species within the potential program areas include plants, birds, fish, mammals, amphibians, reptiles, and at least one insect. The number of listed species currently exceeds 200 and will continue to grow. Because of the number of E&T species that may be found within the areas affected by the Medfly Cooperative Eradication Program, APHIS is working closely with FWS. APHIS is preparing a Biological Assessment to determine if listed species might be affected by program activities. The Biological Assessment will constitute APHIS' programmatic evaluation of the consequences to E&T species, and

is incorporated by reference in this EIS. The Biological Assessment will determine species for which no effect is expected and the FWS will be asked to confirm those findings. For any species that may be affected by the program, APHIS will consult with FWS; formal consultation will culminate in a Biological Opinion issued by FWS. The final Biological Opinion will be the guidance document for program implementation within the range of potentially affected E&T species.

Before implementing a program, APHIS will review the current E&T list to ensure that no additional species that may be affected by program activities have been added. If additional species are in the program area, APHIS will confer with FWS. Previous Medfly infestations have been in urban and suburban areas where natural areas are small and E&T species are few or absent. Previous treatment areas have expanded to include agricultural lands and natural areas only when the eradication programs have been slow to start. Swift initiation of eradication activities upon detection of a Medfly infestation minimizes the area necessary to be treated and prevents the spread of Medfly into areas where E&T species are likely to occur. Therefore prompt program action will minimize the potential for adverse effects on E&T species. Additionally, the incorporation of protective measures provided in the Biological Opinion should further protect E&T species from harm.

6. Biodiversity

a. Chemical Control Methods

(1) Malathion Bait Application

Invertebrate species diversity likely would decrease within the treatment area following application of malathion bait. Insectivorous mammals and amphibians are also predicted to experience declines as a result of aerial spraying. Changes in macroinvertebrate species composition to favor more tolerant species could be expected in areas receiving malathion-containing runoff (CDFG, 1982). Depending on site-specific circumstances, the effects could be brief or protracted. Loss of pollinator species would decrease the number of offspring produced by some species of plants. Because the program is temporary, no plant species should be eliminated from the treatment area, although genetic diversity may be affected. Although individuals of many taxa may be lost, vertebrate population reductions are anticipated to be minor, except for perhaps amphibians. The loss of any individual can reduce biodiversity, but at the anticipated rate, differences between program losses and natural mortality would be difficult to detect for noninsectivorous vertebrates.

Invertebrate taxa would experience the greatest effects. Community structure alterations have been observed and, depending on the aerial spraying regime, could last 1 year or more (Troetschler, 1983). Genetic diversity has been altered by the use of pesticides as evidenced by resistance: malathion is less toxic to mosquitoes than to most other invertebrate taxa. Effects on biodiversity, at all levels, will be less with ground spraying than aerial spraying.

(2) Soil Treatments

The three soil drench chemicals—diazinon, chlorpyrifos, and fenthion—have the potential to affect biodiversity because of the toxicity of these chemicals to a number of nontarget species. However, these chemicals are used only in limited areas and are not very mobile in the environment. Under these limited-use conditions, alterations in biodiversity would be limited. For example, the diversity of the soil invertebrate population in the treated areas would most likely be severely decreased, but untreated areas would still be a source of species for repopulation.

(3) Fumigation

Methyl bromide fumigation associated with the program is unlikely to impact species diversity except in the immediate vicinity of the vent. On rare occasions where invertebrates might be exposed to lethal concentrations of methyl bromide (as in flying through a fumigation chamber's aeration plume), loss of individuals should not affect diversity at the species or population level.

b. Nonchemical Control Methods

(1) Sterile Insect Technique

Sterile insect releases are unlikely to have an effect on biodiversity because the Medflies are infertile and are short-lived. Biodiversity could be affected, however, if fertile flies were released unintentionally. An established exotic Medfly population could affect not only insect diversity, but plant and perhaps vertebrate diversity as well.

(2) Physical Control

Fruit stripping is not expected to affect biodiversity. Host elimination could affect terrestrial and aquatic biodiversity if hosts are eliminated from a large area. Depending on the magnitude of the affected area, landscape diversity could be affected. Aquatic biodiversity would decline as turbidity and siltation from soil erosion associated with host elimination increased. Terrestrial biodiversity would change as well, as more species of plants invaded disturbed areas created by host removal.

(3) Cultural Control

Cultural controls would alter cultivated species diversity in agricultural areas. Indirect effects to those species utilizing this disturbed habitat could occur and alter species diversity locally. Trap cropping could have affects on biodiversity similar to some chemical controls.

(4) Biological Control

Potential effects of biological control on biodiversity may not be predicted with great accuracy, given the present state of Medfly biocontrol technology. Although biocontrol agents considered for use against Medfly could damage populations of a variety of invertebrate species, it is highly unlikely that any of

the biocontrol agents considered would be capable of eliminating populations or causing major fluctuations in community structures. Biodiversity of nontarget plant species would be at risk to the extent that pollination systems may be disrupted.

(5) Biotechnological Control

Potential effects of biotechnological control on biodiversity also may not be predicted with great accuracy, given the present state of Medfly biotechnological control. It is not likely that biotechnological control methods, should they become available to the program, will have a recognizable or major impact on biodiversity.

(6) Male Annihilation

Male annihilation is not expected to affect biodiversity because the chemical lures used on the sticky panels does not attract other species. Incidental trapping of other species may occur, however. The limited distribution of the panels would mean minimal population-wide effects on healthy populations of any nontarget insects that could be attracted to the panels. Male annihilation is not expected to affect biodiversity.

c. Combined Control Methods

(1) Regulatory Control

The components of regulatory control have been analyzed individually. There is little or no potential for impact on biodiversity from regulatory control methods.

(2) Integrated Pest Management

Biodiversity of both plants and animals could be affected by cumulative and synergistic effects of the components of integrated pest management programs. Insect biodiversity could be affected by: population and species reductions from predators, parasites, and biological insecticides; disruption of community trophic interactions; and loss of genetic diversity in insect populations and non-insect populations that depend on insects for food or pollination. In addition, because of the rapid regeneration time of insects, consistent pesticide use alters genetic diversity resulting in increased resistance of many species.

E. Socioeconomics

People potentially affected by Medfly infestations or resulting Medfly eradication efforts may be categorized in several major social groups: agricultural producers (producers of host crops, home gardeners, organic farmers, and beekeepers); pesticide applicators; residents; and consumers. Many other groups may be indirectly affected, but this discussion will be restricted to those groups immediately impacted. The program will result in both benefits and risks for people within these social groups.

The impact of a program on agricultural producers will be, for the most part, beneficial. The Medfly represents a threat to numerous crops, and its establishment could lead to substantial losses of produce, income, and export markets (see Draft Economic Analysis of Medfly Program, incorporated by reference). These losses could be most serious for small farmers and people dependent upon gardens for a substantial portion of their food. A Medfly Cooperative Eradication Program will protect both crops and income, as well as alleviating the need for (and cost of) uncoordinated farm-by-farm eradication programs.

There are some risks for agricultural producers from a program, particularly a program which uses pesticides. These risks include the potential mortality of natural and introduced pest predators, the loss of "pesticide-free" status (and thus certain markets) for organic farmers, and potential mortality of honey bees. The risk to honey bees can be substantially reduced by early notification of beekeepers so that they can take precautions to protect their hives. With proper precautions there should be no loss of hives due to pesticide use (see chapter VI regarding mitigative measures).

A program using pesticides will create both benefits and risks for pesticide applicators. The emergency nature of an eradication program and its intensive work schedule will probably create additional income for pesticide applicators. There are some health risks for pesticide applicators, although the use of protective clothing greatly reduces these risks (see section on human health).

The residents of an area infested with Medfly will receive both benefits and risks from a Medfly Cooperative Eradication Program. The benefits will include the protection of backyard and ornamental host plants from the Medfly. The risks will be those associated with pesticide use, although only certain subpopulations of the area residents are at risk due to program pesticide use (see section on human health).

The largest group of program beneficiaries includes anyone who consumes produce that is a host of the Medfly. Because commercial farms and orchards ship produce to other states and countries, this group encompasses a wide spectrum of people. The Medfly Cooperative Eradication Program benefits this social group by preserving the current availability and cost of certain produce. Federal regulations governing pesticide residues on produce protect the general public from any risks associated with pesticides used in a program (see section on human health).

The potential for the rapid spread of Medfly infestations requires that programs be initiated soon after infestations are detected. Medfly outbreaks often occur first in urban/residential areas, thus nonagricultural areas are involved. Under these conditions, the distribution of benefits and risks of the program among various social groups can be somewhat inequitable. Even under the no action alternative (no Federal cooperation in eradication efforts), state and private eradication programs would create risks similar to those that might result from the Medfly program. Because the potential distributional inequity of the program is unavoidable, every effort is made to reduce risks

from the program to all social groups (see chapter VI regarding mitigative measures).

F. Cultural and Visual Resources

1. Chemical Control Methods

Malathion bait aerial applications have potential to adversely affect cultural and visual (scenic) resources through direct or indirect effects on nontarget species that are associated with or comprise the resources. The effect of malathion aerial bait spray on cultural and scenic resources such as gardens, parks, zoos, arboreta, forests, and wildlife refuges will depend to a large extent on the animal and plant species they contain. Standard operational procedures (such as notification of residents within a spray area and avoidance of water bodies) generally help to limit the exposure of wildlife in zoos, arboreta, gardens, and ponds.

Malathion bait aerial applications are known to affect some types of car paint, but no data exist on potential effects of malathion bait spray on the types of paint found on historical buildings or Native American petroglyphs. However, archaeological sites are not likely to be treated, and the vertical walls and exposures of the petroglyphs would serve to minimize exposure to any bait spray. Cultural practices, such as wild food gathering by Native Americans on Indian reservations, could be temporarily halted due to malathion bait aerial spraying.

Other chemical control methods will have little to no effect on cultural or scenic resources. The soil drench chemicals and malathion ground spray may affect those resources if substantial mortality of nontarget species were to occur as a result of treatment. However, the soil drench chemicals and malathion ground spray are used in limited areas and any resulting impacts would be minimal and localized. Methyl bromide fumigation should not have any impact on cultural or scenic resources because fumigation generally is not conducted in or near cultural or scenic resources. The use of traps in gardens or around historic sites may temporarily detract from the appearance of cultural and scenic resources.

2. Nonchemical and Combined Control Methods

Nonchemical control methods are expected to have minimal effect on cultural and scenic resources of the program area. Equipment (aircraft or trucks) used to release sterile Medflies may affect those resources only to the extent that the activity or noise may disturb visitors to these resources. Physical control methods may affect the appearance of public and private gardens; fruit stripping would not result in harm to plants, but host removal could change the appearance of gardens. Cultural control should not affect cultural resources because it involves agricultural lands that generally are not considered cultural resources. Neither physical control nor cultural control will be applicable in scenic areas such as national forests or wilderness areas because of the resources' large sizes and nonagricultural nature. The potential effects of biological and biotechnological control on cultural resources would depend on the species-specificity of the controls, the relative contribution of nontarget species to the particular resource, and the effect on the species. Mortality of

insects is not likely to directly affect cultural resources but adverse effects on plants could change the appearance of gardens. The establishment of quarantine checkpoints under regulatory control, and the associated traffic, noise, and signboards, may affect nearby cultural resources such as Indian reservations. The effect of integrated pest management on cultural or scenic resources would depend on the component control methods used.

G. Cumulative Effects

1. Chemical Control Methods

Cumulative effects or impacts are defined as those effects or impacts that result from the incremental impact of a program action when added to other past, present, and reasonably foreseeable future actions. Cumulative effects may result from direct effects which are caused by the action and occur at the same time and place, or they may result from indirect effects which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. The potential cumulative effects of the Medfly Cooperative Eradication Program are related principally to the program's use of chemical control methods. Such effects could result from accumulation of pesticide(s) in the environment or within organisms, interactions of program pesticides with other pesticides or chemicals, or repeated exposures of humans or nontarget organisms to pesticides (incremental effects).

No environmental accumulation or bioaccumulation is foreseen for program use of malathion; malathion degrades rapidly and the interval between expected treatments is such that little residue of malathion from previous applications would remain or have the potential to exacerbate the risk of subsequent applications. Although soil drench pesticides are expected to have limited usage over a minimal portion of the treatment area, short-term accumulation in soil is possible (half-lives in soil range from 1 day for fenthion to as long as 10 weeks for diazinon); however, residues should not persist long in the environment under usual conditions. Methyl bromide is volatile and is not expected to accumulate in the vicinity of the treatments, although there is concern that halogens (including bromine) may accumulate in the atmosphere and contribute to ozone depletion in the stratosphere; however, the small amounts of bromine in the atmosphere are not believed to be important causes of ozone destruction.

Cumulative effects may include synergistic toxic effects resulting from exposure to pesticides that have combined with other pesticides or chemicals. Although organophosphate pesticides may have potential to interact, the program organophosphate pesticides usually are not applied simultaneously; even though an individual may be exposed to two organophosphates within the same exposure interval, the implications of such an exposure are unclear. There also is some potential for synergistic effects resulting from the combination of program pesticides and pesticides or chemicals used by the public. Chemicals routinely used by the public include pesticides, household cleaners, lawn and garden chemicals, and home maintenance products. There is no way to predict with certainty the use of such products, the extent of their synergism, the

potential for exposure to synergistic products, or the consequences of that exposure. Public notification will help to minimize exposure and resultant risk of any synergistic effects.

Exposure to chemicals can lead to allergy or hypersensitivity (EPA, 1984; Calabrese, 1978). Effects such as hypersensitivity often depend on cumulative or multiple exposures. Groups that may be hypersensitive to organophosphate pesticides include: individuals with immature enzyme detoxification systems (embryos, fetuses, neonates, and children to 3 months of age), pregnant females, individuals with highly sensitive cholinesterase variants, individuals low in dietary protein, individuals with liver disease or impaired immune function, alcoholics, and drug users. All people at some time during their lives are at increased risk from one or more commonly encountered environmental contaminants. Effects that could result from repeated exposures to environmental contaminants include dermal sensitivities, respiratory effects, and (rarely) some life-threatening conditions. In order to minimize exposure for individuals who could be sensitive or become sensitive to the organophosphate pesticides, program operational procedures are designed to protect sensitive areas (including hospitals) and provide public notification of planned applications.

Cumulative effects may result from the incremental use of program pesticides. Other pesticides have been implicated in the decline of amphibian and bird species. Theoretically, adverse effects on nontarget species' populations may be exacerbated and the populations permanently impacted if the treatment intervals are shorter than the time required for regeneration and the populations cannot recover. Long-term effects to nontarget species could also result from minor population changes from treating the same area in different programs in successive years; the long-term effects of individual losses from a population are difficult to predict. Also, even though the program pesticides are not persistent, their temporary presence could contribute to the overall pesticide load of an area, especially if nonprogram pesticide use is involved.

2. Nonchemical and Combined Control Methods

The effects of nonchemical control methods on human health and safety have been evaluated and found to have little, if any, impact. Therefore, long-term or cumulative impacts are not expected. Some of the nonchemical control methods may cause temporary disturbances to nontarget habitats or ecological associations, but because the effects are of short duration and reversible, long-term or cumulative effects on populations are unlikely. Because immediate effects of biological control and biotechnological control are not well established, it is impossible to predict cumulative impacts to nontarget species from these control methods.

The potential cumulative effects of the combined control methods would depend on the component control methods used, but are substantially influenced by the use of control methods using pesticides. These components have been analyzed separately.

H. Unavoidable Environmental Effects

1. Chemical Control Methods

Unavoidable environmental consequences of the program chemical control methods would vary with the pesticide, the pesticide's mode of action, the pesticide's application rate and regime, the size of the treatment area, site-specific environmental factors, and temporal considerations including timing and length of the program. Program pesticide usage will increase pesticide load to the environment. Effects may vary according to pesticide residence time, persistence, and transmigration, but because those pesticides used in the program are not Medfly-specific, many nontarget species will be affected.

Individual humans exposed to pesticides vary with respect to their responses. People who are sensitive to pesticides could be affected from even small quantities of pesticides in the environment, if they do not take measures to minimize their exposure. Similarly, applicators who do not follow established safety procedures could be affected from repeated exposures.

Aerial spraying of malathion bait has the potential for the most unavoidable effects because of its broadscale application. Many invertebrate species may suffer high mortality and secondary pest outbreaks, which have occurred in the past, are anticipated in future efforts. Insect species diversity will be reduced. Without proper protective measures, honey bee and other pollinator losses would occur. Some indirect effects to plant species may result from effects on invertebrate pollinators (including possible reduction in genetic diversity), but those consequences are restricted spatially and should diminish over time and with repopulation from surrounding areas. Vertebrate insectivores would also be affected due to loss of food supply and secondary poisonings which could occur, particularly in immature populations and other susceptible life stages.

The physical aspects of aerial application, including noise, will disrupt activities of some populations. Although the effects should be temporary, nest abandonment may occur with more sensitive avian species. A segment of the human population is also greatly disturbed by the physical aspects of the treatment and opposition will be voiced in many areas.

Although larger water bodies are avoided during aerial application, smaller ponds and riparian zones usually are sprayed or receive drift. Depending on the amount of spray reaching these aquatic habitats, water quality criteria will be exceeded and invertebrates, fish, and amphibians will be affected. Repeated sprays will increase the adverse consequences.

Although soil drenches are hazardous to many vertebrate species, few individuals will be exposed because of the limited nature of those treatments. Localized alterations in populations of soil micro-organisms are unavoidable with soil drenches. Depending on soil characteristics, soil drench chemicals can be relatively persistent. Wild and domestic animals that utilize the treated area could be affected for weeks to months after treatment. Humans, particularly children, who contact treated soil also will be affected. Although runoff is not predicted in most regions, where it occurs, aquatic habitats could receive concentrations that exceed water quality criteria (chlorpyrifos). Methyl bromide

fumigation will release bromine into the atmosphere. Vehicular emissions will contribute to air pollution.

2. Nonchemical and Combined Control Methods

Use of the nonchemical control methods may result in localized unavoidable environmental effects, such as inducing flight in some birds due to use of vehicles. Minimal physical habitat alteration may occur from vehicular traffic and equipment employed to implement program treatments. Some soil compaction and erosion and aquatic habitat disruption could result if physical controls are widespread. Although not immediately applicable to the program, biological and biotechnological controls are usually not species-specific and could have unintended effects. Minor unavoidable effects (e.g. soil disturbance or unintentional trapping of nontarget individuals) are anticipated from male annihilation.

Regulatory controls will result in noise and air pollution and will add to the waste stream. Chemical components will have the effects described above. Integrated pest management will combine effects from chemical controls and nonchemical controls and will have all effects thus far described.

The combination of control techniques anticipated in the program are not unlike many agricultural activities, and effects will be similar. Unavoidable effects from chemical control methods have been identified above. An important consideration is the rapid implementation of these activities. The earlier an infestation is detected and treatments started, the fewer the environmental effects will be. If, on the other hand, an infestation covers a broad area, many techniques may have to be employed over a larger area for a longer time period, with subsequent increases in detrimental effects.

VI. Standard Operational Procedures and Program Mitigative Measures

A. Introduction

The standard operational procedures and recommended program mitigative measures which have been developed for the Medfly Cooperative Eradication Program reflect the concern of the Animal and Plant Health Inspection Service (APHIS) and its cooperators for protecting and conserving environmental quality. Each category of actions serves to negate or reduce environmental impact.

Standard operational procedures are routine procedures that are required of the program and its employees for the purpose of safeguarding human health and the natural environment. Standard operational procedures are developed for most APHIS programs and originate from a variety of sources; they are often the same or similar for many programs. Standard operational procedures also may be referred to as program safeguards or precautions.

Program mitigative measures are recommended for the purpose of avoiding, reducing, or rectifying environmental impact. The mitigative measures recommended for the Medfly Cooperative Eradication Program have been developed specifically for the program; they take into account unique characteristics of the program and may differ from those used for other programs.

B. Standard Operational Procedures

The standard operational procedures (table VI-1) reflect: (1) the emphasis that APHIS and the program cooperators place on establishing and maintaining technical competency in their personnel, (2) the degree of control that must be exercised over program operations, and (3) the monitoring that is done to ensure the environmental soundness of the program. Through a combination of technical competency and environmental awareness, program personnel minimize the potential for environmental impact.

As part of the standard operational procedures, program personnel are required to be trained in program procedures, pesticide application, and safety procedures. APHIS personnel associated with the program are required to be trained and certified as pesticide applicators. All applicators (including contractors) are trained and routinely briefed by program staff on proper operational procedures, application procedures, safety procedures, delineation of treatment areas, and site-specific considerations. Applicators are briefed before beginning work and provided with the most current information on the area(s) to be treated. This thorough approach prevents application errors which could result in ineffective or unnecessary applications because of a lack of knowledge of the treatment area.

Another major component of the standard operational procedures is the comprehensive monitoring plan developed for the program to confirm both the efficacy and environmental soundness of the program treatments. The plan is generic and routinely adaptable to all potential program areas, but may be modified because of site-specific characteristics of a program area. The data derived from monitoring is also used to confirm or modify standard operational procedures and mitigative measures to reduce environmental risk.

C. Recommended Program Mitigative Measures

Program mitigative measures (table VI-2) have been recommended to negate or reduce potential impact on humans, nontarget species, and the physical environment. In general, the mitigative measures represent modifications to the program or extra steps taken to negate or reduce environmental impact.

The principal focus of the mitigative measures for the protection of human health is the notification to residents of projected treatment areas. That notification tells residents when and what to expect, how it might affect them, and what they can do to protect themselves from any adverse effects.

Mitigative measures for nontarget species include: special protection measures and notification for beekeepers; a consultation process with the U.S. Department of the Interior's Fish and Wildlife Service to ensure protection measures for potentially affected endangered and threatened species; and measures to protect wildlife, pets, and livestock.

The physical environment is protected by recommended mitigative measures in a number of ways, including: buffer zones around water, use of alternative treatment methods, avoidance of sensitive sites, coordination, and technical review.

Table VI-1. Standard Operational Procedures

A. General

1. All applicable environmental laws and regulations will be followed.

2. All program personnel will be instructed on procedures and proper use of equipment and materials. Field supervisors will emphasize these procedures and monitor the conduct of program personnel.

3. All materials will be used, handled, stored, and disposed of according to applicable laws so as to minimize potential impacts to human health and the environment.

4. All applications will be made and timed in such a manner as to avoid potential impact to the public and nontarget organisms, including endangered and threatened species.

5. Environmental monitoring of the program will include, at a minimum, the monitoring components of the general monitoring plan included in this document, but may be more extensive depending on the program area.

B. Chemical Applications

1. All pesticides will be applied by certified applicators according to label instructions and applicable quarantine or emergency exemptions.

2. All pesticides will be stored according to U.S. Environmental Protection Agency guidelines and local regulations. Pesticide storage areas will be inspected periodically.

3. All mixing, loading, and unloading will be in an area where an accidental spill will not contaminate a stream or other body of water.

4. To the degree possible, pesticides will be delivered and stored in sealed bulk tanks, and then pumped directly into the tank of the aircraft or ground equipment.

5. Any pesticide spills will be cleaned up immediately and disposed of in a manner consistent with the label instructions and applicable environmental regulations.

6. All program personnel will be instructed on emergency procedures in the event of accidental pesticide exposure. Equipment necessary for emergency washing procedures will be available.

7. All APHIS employees who plan, supervise, recommend, or perform pesticide treatments are also required to know and meet any additional state and local qualifications or requirements of the area where they perform duties involving pesticide use.

8. All pesticide applicators will meet state licensing requirements for the program area state; reciprocal Federal/state licensing agreements may be honored for this purpose.
9. Pilots, loaders, and other personnel handling pesticides will be advised to wear proper safety equipment and protective clothing.
10. Manufacturers' Safety Data Sheets for program pesticides will be made available for program personnel.
11. Program officials will notify hospitals and public health facilities of pesticide treatment schedules and the types of pesticides used.

C. Aerial Operations

1. Prior to beginning operations, aerial applicators will be briefed by program staff regarding operational procedures, application procedures, treatment areas, local conditions, and safety considerations.
2. Flags or other markers will be used in areas without natural landmarks for pilot guidance.
3. All lead aircraft will use loran RNAV-R-40 guidance systems or an equivalent system to assure the accurate placement of insecticide. All aircraft used in aerial insecticide application will use the Pathlink System or an equivalent system which provides a permanent record of the flight and applications.
4. To minimize unavoidable exposure, aerial chemical applications will not be made to areas occupied by agricultural workers.
5. Program personnel will use dye cards (cards sensitive to malathion bait spray), as needed, to determine swath width during calibration and monitoring. Dye cards are used in monitoring to validate swath width and droplet size, and for evaluation of the potential for drift.
6. Aircraft, dispersal equipment, and pilots that do not meet all contract requirements will not be allowed to operate.

D. Ground Operations

1. Ground applications of chemical pesticides will be made to Medfly host environments only.
2. To minimize unavoidable exposure, ground chemical applications will not be made to areas occupied by agricultural workers.

Table VI-2. Recommended Program Mitigative Measures

A. Protection of Human Health

Workers

1. Applicators of chemical pesticides will be advised to have periodic cholinesterase testing.
2. Unprotected agricultural workers will be advised of the respective reentry periods following treatment in agricultural crop areas.

The Public

1. Program personnel shall notify area residents by at least 24 hours (but in practice, often as much as 1 week) in advance of the date and time of planned pesticide treatment.
   a. Notifications will be in English, Spanish, or other languages as necessary, based on the ethnic structure of the community.
   b. The notification shall include basic information about the program and, if applicable, aerial application procedures to prepare residents for the presence of aircraft.
2. Any residents who are listed on state public health registries as hypersensitive to chemical exposure will be informed of the planned times and locations of all applications of malathion bait spray. They will also be advised that they may contact their physicians regarding ways to minimize their exposure to program chemicals.
3. Residents will be advised to remain indoors, take pets indoors (or provide cover for them), and cover garden fish ponds during spraying operations.
4. Residents will be advised to cover cars to protect them from possible damage caused by the bait spray.
5. A telephone hot line will be established before an eradication program and maintained during the program to keep the public informed of the most current and complete information available.

B. Protection of Nontarget Species

1. Honey Bee Protection
   a. APHIS or a state cooperator will notify registered beekeepers of program treatments before chemical applications are conducted.
   b. Information describing protection measures which can be taken by beekeepers to protect their colonies will be made available through beekeeper associations and State Agricultural Extension Agents.

(1) Colonies which are ¼-mile or more from the application should not sustain significant loss, providing the bees are not foraging within the spray area.

(2) If bees are foraging within the proposed spray area, the beehives should be moved a distance of at least 5 kilometers (3.1 miles) outside of the proposed spray area.

(3) If it is not possible to move the beehives, protection may be provided through the use of burlap tarpaulins. The beehives may be kept covered for at least 2 days, providing the burlap is kept damp with water. Food in the form of sugar water should also be made available to the bees.

c. The telephone hot line will describe protective procedures for bee keepers in addition to its primary function of informing the general public and answering questions concerning the Medfly eradication program.

2. Beneficial Species

a. Program managers will consult with state plant protection officials regarding programs involving the use or release of beneficial species and biocontrol agents and will adhere to any recommendations provided by the state officials.

3. Endangered and Threatened Species

a. APHIS or its designated non-Federal representative will consult with the U.S. Department of the Interior's Fish and Wildlife Service, under the provisions of the Endangered Species Act, section 7, for the protection of endangered and threatened species.

b. APHIS will prepare a biological assessment for federally listed endangered, threatened, and proposed species found within the proposed program areas.

c. APHIS will adhere to protective measures proposed by the Fish and Wildlife Service in informal section 7 consultation or in a biological opinion.

4. Wildlife, Livestock, and Pets

a. All control operations will be conducted with appropriate concern for potential impact on nontarget organisms, including wildlife, livestock, and pets.

b. Homeowners and agriculturalists will be advised by written notification and telephone hot line of the ways in which they can protect livestock and pets.

C. Protection of the Physical Environment

1. Program activities will take into account site-specific aspects of the program area and will be tailored accordingly to maximize program efficiency and minimize potential adverse effects.

2. Treatment areas will be inspected before any treatment to determine the presence, location, and nature of sensitive areas. Where aerial applications could result in an unacceptable potential risk to a sensitive area, the program manager(s) will determine the need for approved alternative controls, as described in this analysis.

3. Aerial chemical applications will not be made where water contamination poses a major concern. No aerial pesticide applications will be made within 200 meters (656 feet) of any major body of water. When necessary, aerial markers are placed to indicate the buffer zones around water bodies.

4. Applications will be made by helicopters in areas of rough terrain, enhancing accurate delivery of pesticides as well as increasing the safety of applicators.

5. To minimize drift, volatilization, and runoff, pesticide applications will not be made when any of the following conditions exist in the treatment area: wind velocity exceeding 10 mph (or less if required by state law), rainfall or imminent rainfall, foggy weather, air turbulence that could seriously affect the normal spray pattern, or temperature inversions that could lead to off-site movement of spray.

6. Sensitive areas (including reservoirs, lakes, parks, zoos, arboretums, schools, churches, hospitals, recreation areas, refuges, and organic farms) near treatment areas will be identified. The program will take appropriate action to ensure that these areas are not adversely affected.

7. To the maximum extent possible, program managers will coordinate with other programs to reduce potential for cumulative impacts.

VII. Monitoring

A. Introduction

The Animal and Plant Health Inspection Service (APHIS) and its cooperators will monitor treatment areas in order to determine the environmental consequences and the efficacy of the Medfly Cooperative Eradication Program. Environmental monitoring is done in accordance with responsibilities under the National Environmental Policy Act to assess the potential environmental impacts of the program. Efficacy monitoring (also called quality control monitoring) is done to confirm the efficacy of the treatments. Program monitoring is a cooperative effort involving Federal, state, and county personnel.

B. Environmental Monitoring

APHIS has developed a generic environmental monitoring plan, intended to serve as a basis for environmental monitoring anywhere within the potential program area. The plan may be modified based on site-specific aspects of the actual treatment area at the time a program is implemented. Environmental monitoring of program uses of malathion, diazinon, fenthion, and chlorpyrifos involves sampling of environmental components (to confirm that no pollution occurs) and agricultural commodities (to ensure established residue tolerances are not exceeded). Because of methyl bromide's volatility and pattern of use, methyl bromide residues would not be expected to remain in environmental components.

Environmental components to be sampled include water, air, soil, foliage, and biological organisms. The number of sampling sites and the frequency of sampling may be adjusted, based on site-specific characteristics of the program area. Concentrations of pesticides and their degradation products will be measured in areas such as wetlands, wells, or streams adjacent to the treatment area to assess the potential for environmental impacts associated with a pesticide treatment and to verify the efficacy of the program mitigative measures. Samples of specific environmental components may also be taken if there are complaints about the program's impacts, treatment protocols, or mitigation measures. In the event of a pesticide spill, environmental samples will be taken to determine the magnitude of the spill and to determine the types of mitigative measures that are necessary. The monitoring procedures to be followed after spills are outlined in the guidelines, policies, and manuals of APHIS and program cooperators.

C. Efficacy Monitoring (Quality Control Monitoring)

For chemical treatments (methyl bromide, diazinon, chlorpyrifos, fenthion, and malathion), the purity of the chemical and the accuracy of the formulation will be determined. Program pesticide applicators will follow standard operating

procedures described in this environmental impact statement and in the guidelines, policies, and manuals of APHIS and program cooperators.

Efficacy monitoring will be done also to confirm accurate placement and delivery of pesticides. Aerial applications will be monitored using dye cards that show the size and distribution of pesticide droplets that reach the ground. Dye cards will also be used to verify the placement of pesticide in proximity to boundaries of the treated area, identify areas that were skipped, and estimate the amount of drift.

VIII. Environmental Laws, the Program, and the EIS

A. Introduction

In the planning and implementation of its programs and actions, the Animal and Plant Health Inspection Service (APHIS) willingly complies with a number of environmental statutes and regulations. Most of those statutes and regulations have the underlying objective of forcing Federal managers to comprehensively consider the environmental consequences of their actions before making any firm decisions. In addition, the statutes and regulations provide guidance in the procedures that must be followed, the analytical process itself, and in ways of obtaining public involvement. This environmental impact statement is prepared specifically to meet the needs of the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. 4321.

B. APHIS Environmental Policy

APHIS strives to comply with environmental regulations and statutes as an integral part of the decisionmaking process to identify and consider available alternatives that lead to more successful programs. NEPA is the origin of current APHIS environmental policy. It requires each Federal agency to publish regulations implementing its procedural requirements. APHIS published the "APHIS Guidelines Concerning Implementation of NEPA Procedures" (44 FR 50381-50384, August 28, 1979). These guidelines are currently under revision. APHIS bases its current procedures on: NEPA itself; the Council on Environmental Quality's "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act," 40 CFR 1500, *et seq.*; the U.S. Department of Agriculture's "NEPA Regulations," 7 CFR 1b, 3100; and the "APHIS Guidelines Concerning Implementation of NEPA Procedures."

C. National Environmental Policy Act

NEPA requires Federal agencies to consider environmental consequences in their planning and decisionmaking processes. It requires them to prepare detailed statements (environmental impact statements) for major Federal actions which significantly affect the quality of the human environment. These statements must consider the environmental impact of the proposed action, adverse effects which cannot be avoided should the proposal be implemented, alternatives to the proposed action, the relationship between local and short-term uses of the human environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources necessary to implement the action. NEPA provided the basis for many other statutes and environmental regulations within the United States.

NEPA established the President's Council on Environmental Quality which published regulations for the implementation of NEPA that became effective in 1979. They were designed to standardize the process that Federal agencies must use to analyze their proposed actions. Those regulations have been the models for the NEPA implementing regulations that have been promulgated by Federal agencies.

D. Endangered Species Act

The Endangered Species Act of 1973 (ESA), 16 U.S.C. 4332, *et seq.*, was passed to provide for a Federal mechanism to protect threatened and endangered species. This act provides for an analysis of the impact of Federal programs upon listed species. Under ESA, animal and plant species must be specifically listed in order to gain protection. Federal agencies proposing programs which could have an effect on listed or proposed endangered and threatened species prepare biological assessments for those species. Those biological assessments analyze potential effects and describe any protective measures the agencies will employ to protect the species. A consultation process, section 7 consultation (after that section of the Act), is employed as needed. Such consultation is important to APHIS' environmental process and then becomes an integral part of the proposed program.

E. Miscellaneous Federal Environmental Statutes

A number of other acts, statutes, and regulations exist and are complied with by APHIS. These include the Migratory Bird Treaty Act; Bald and Golden Eagle Act; Federal Insecticide, Fungicide, and Rodenticide Act; Toxic Substances Control Act; Resource Conservation and Recovery Act; Comprehensive Environmental Response, Compensation, and Liability Act of 1980; Clean Air Act; and Clean Water Act.

F. State Environmental Statutes

The potential program states all have various environmental statutes and regulations. Many of the regulations and regulatory organizations that enforce them are direct parallels of the Federal regulations and regulatory organizations. California, for example, has the California Environmental Quality Act and has recently organized the California Environmental Protection Agency.

The proposed Medfly Cooperative Eradication Program is a cooperative one in which APHIS will work with state and/or other Federal agencies to implement control actions within one or more areas within nine states. APHIS will rely on its program cooperators to identify applicable state environmental regulations, take the lead for their procedures, and ensure full compliance with state laws.

IX. Conclusions

The Medfly is a major pest of agriculture throughout the world and represents a serious threat to U.S. agriculture. The Animal and Plant Health Inspection Service (APHIS), with other Federal and state organizations, is proposing the Medfly Cooperative Eradication Program to eradicate the Medfly from areas of the conterminous United States that it may infest in the future. APHIS and its cooperators have prepared this environmental impact statement (EIS) for the proposed program in accordance with the National Environmental Policy Act of 1969 and the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.

The following alternatives were considered: no action, Medfly suppression (including chemicals), Medfly suppression (no chemicals), Medfly eradication (including chemicals)—the preferred alternative, and Medfly eradication (no chemicals). Each alternative was determined to have potential for adverse environmental consequences—consequences related to program use of control methods or, in some cases, resultant nonprogram use of control methods. No action was determined to have the highest potential for adverse environmental effects because it would ultimately lead to an expanded Medfly population with resultant increased and uncontrolled use of pesticides. Medfly eradication (including chemicals) was chosen as the preferred alternative because of its capability of achieving the eradication objective in a short period of time, thereby reducing the need for continued pesticide treatments.

Chemical and nonchemical control methods were analyzed in detail; the EIS focused on chemical control methods because they have the greatest potential for adverse environmental consequences. The soil drench chemicals were determined to have the greatest potential for adverse human health effects, while malathion aerial bait applications were determined to have the greatest potential for adverse nontarget species effects. Nonchemical control methods offer little, if any, potential for adverse environmental consequences.

Human health and nontarget species risk assessments (incorporated by reference) determined varying degrees of risk for components of the human environment; greater risks were determined for some nontarget species and for pesticide applicators than for other environmental components (including other nontarget species, the general public, and the physical environment). Use of chemical control methods may result in some short-term cumulative effects. The chemical control methods may also result in unavoidable environmental effects, including increased pesticide load to the physical environment, some reductions of exposed terrestrial and aquatic invertebrate populations, and some alterations in soil micro-organism structure.

In conclusion, the EIS identified and analyzed a broad range of alternatives and control methods for the Medfly Cooperative Eradication Program. Widely varying environmental consequences were associated with those alternatives and control measures. Generally, the program's standard operational procedures and recommended mitigative measures will serve to negate or

reduce environmental risks. The broad range of available control methods offers substantial flexibility and latitude, so that controls may be selected, based on further site-specific consideration, to achieve both operational and environmental objectives.

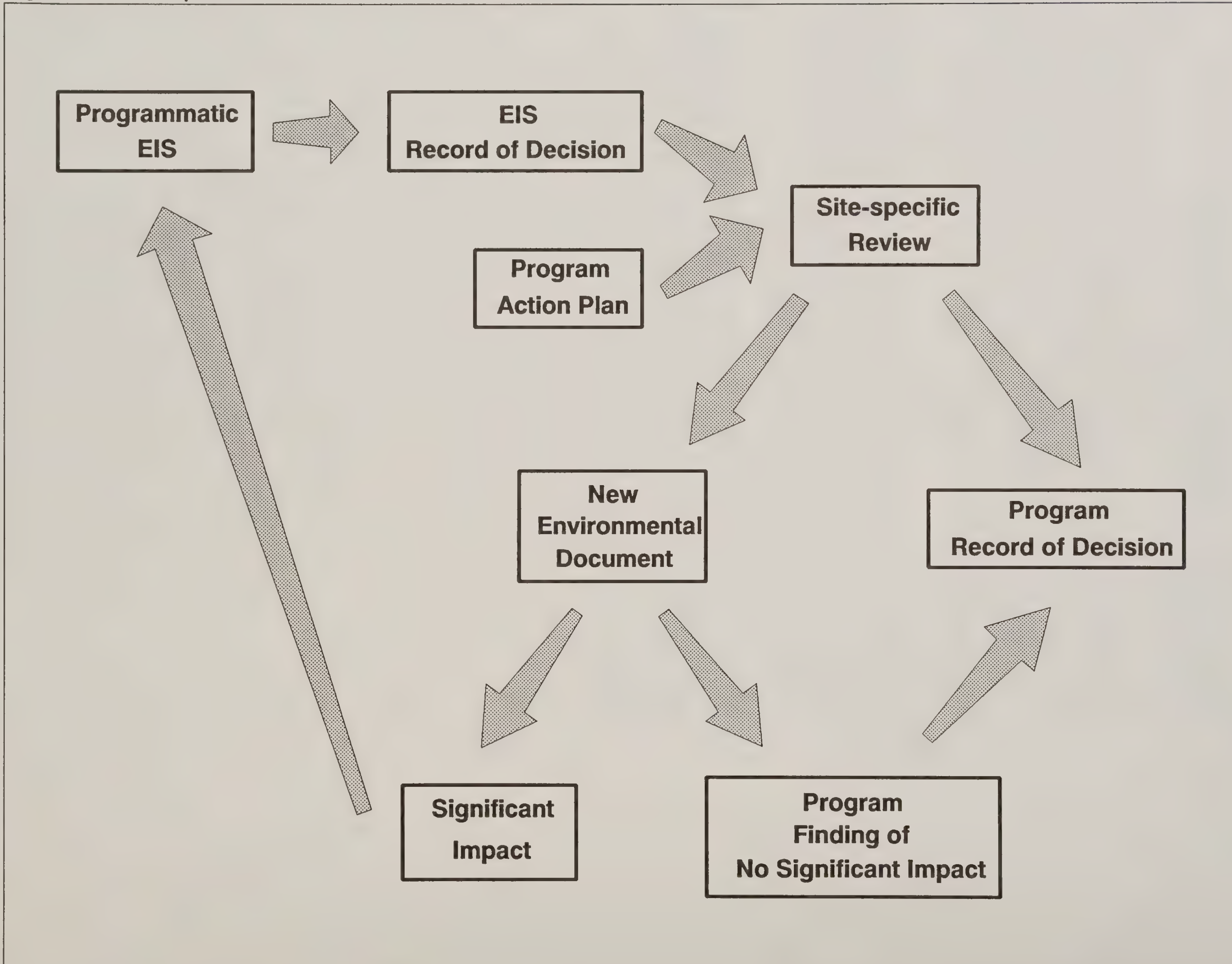
Appendix A. Site-specific Evaluation Procedures

A principal goal of the Animal and Plant Health Inspection Service (APHIS) and its cooperators is to implement each Medfly progam in a manner that achieves its control objective while preserving the quality and diversity of the human environment. Accordingly, before a program is implemented, program managers take an in-depth look at the site-specific characteristics of the potential progam area (local geographic features, human health, and nontarget species) and the program's proposed operational procedures and control methods.

The site-specific evaluation process (figure A-1) considers characteristics such as: (1) unique and sensitive aspects of the proposed program area, (2) applicable environmental and program documentation, and (3) applicable new developments in environmental science or control technologies. To assist program managers in their evaluations, a generalized list of considerations has been recommended, and is provided in this appendix.

In addition to furthering the objectives of and complying with the National Environmental Policy Act, our site-specific evaluation will determine if the general findings of this programmatic environmental impact remain equally applicable to each individual program's specific situation and whether additional or new concerns are present. In cases where major changes are apparent, a supplement to the EIS or a new EIS may be required.

Figure A-1. Site-specific Environmental Review Process



Medfly Cooperative Eradication Program Site-specific Considerations

Physical Environment

A. Land

1. General characteristics of the program area
   a. Contours and slope of the program area
   b. Land use in program area (predominantly rural or urban)
   c. Presence of impervious surfaces (such as buildings, roads, and blacktop) that affect runoff of pesticides
   d. Extent of tree cover (open or canopied)
   e. Soil characteristics of the program area

B. Water

1. Presence of major water bodies, large drainage ditches, or wetlands (especially wetlands afforded special protection) in the program area
   a. Need for visual identification of water bodies or wetlands within the program area
   b. Need for buffers or boundary markers around water bodies or wetlands
2. Climatic conditions that might affect water within the program area
3. Presence of subsurface aquifer(s)
4. Primary sources of public drinking water

C. Air

1. Prevailing meteorological conditions and their potential effect on drift
2. Windspeed restrictions for applications

D. Sensitive Sites

1. Presence of sensitive sites within the program area that require special measures (such as avoidance, alternate treatment method, and notification)
2. Presence of sites where outdoor events that result in large congregations of humans
3. Monitoring to ensure and document no off-site movement of pesticides to sensitive sites

Human Health

A. Workers

1. Mandatory training in safety, emergency, and cleanup procedures for program pesticide applicators, mixers, and loaders
2. Compliance with state and local pesticide laws
3. Mixing and loading areas are located where area or groundwater contamination is not likely and where cleanup is facilitated
4. Baseline cholinesterase testing of pesticide applicators, mixers, loaders, and pilots
5. Unprotected farm workers advised of reentry periods following treatment with program pesticides, if applicable

B. The General Public

1. Population density factored into program decisions
2. Applications timed to minimize exposure to the general public
3. Notification plan (radio, newspapers, written notification to residents)
   a. Dates, times, and places of applications
   b. Notification in a language other than English, based on ethnic diversity of area
4. Media or public "hot line" to provide answers to questions
5. Notification of public health agencies and advisory regarding pesticide formulations used

C. Special Considerations

1. Special characteristics of the human population (such as age structure) effects on timing and selection of treatments
2. Special steps to reduce exposure of the public to chemicals determined to have sensitizing, carcinogenic, or other unique toxicological properties
3. Additional procedures or protective measures for chemically-sensitive people identified on state registries or their equivalent

Nontarget Species

A. Plants

1. Relative abundance and diversity of plant in the program area
2. Unique circumstances where losses to pollinator populations could impact survival of plant populations.

B. Bees

1. Presence of commercial or hobby honey bee apiaries in the program area
2. Presence of managed colonies of leafcutter bees in the program area
3. Notification of registered beekeepers of the time and place of the treatments
4. Precautions for protection of bees

C. Wildlife

1. Unique problems with regard to the need for protection
2. Nesting or mating of avian species in identifiable areas

D. Livestock and Pets

1. Notification to take in pets and cover garden fish ponds
2. Any special protective measures for livestock

Endangered and Threatened Species

A. Federally Listed Endangered and Threatened Species in the Program Area

1. Results of consultation with the Fish and Wildlife Service under section 7 of the Endangered Species Act
2. Special protective measures required by biological opinion

B. State Listed Endangered and Threatened Species in the Program Area

1. State consultation with the state fish and game department on the protection of those species
2. State contact with applicable nature conservancies or natural heritage foundations to determine presence of species
3. Potential conflicts on protection measures

Control Methods and Considerations

A. Chemical Control Methods

1. Applicable laws and regulations
   a. Chemical registrations (standard, emergency, or local needs)
   b. Availability of labels and precautions for those who use or handle pesticides

c. Compliance with applicable state and local laws

d. Emergency notification, decontamination, and waste disposal requirements

2. Management of program uses of chemicals

a. Formulations and application

b. Application methods and equipment

c. Frequency of application, given the conditions or characteristics of the treatment area

d. Restrictions on applications (maximum windspeed, rainfall, time of day, and other restrictions)

e. Cumulative effects from program and nonprogram uses of pesticides in the area

3. Coordination with other nonprogram pesticide applications (where appropriate) to ensure efficacy and minimum environmental impact

4. Monitoring plan

5. Influence of any unavoidable environmental impacts

B. Nonchemical

1. Quarantine orders and other documentation for fruit stripping or other physical methods

2. Arrangements for landfill or other disposition of removed host material

3. Any regulatory restrictions for activities involving release of sterile insects

Appendix B. Endangered and Threatened Species

State	County	Scientific name	Common name	Federal status
Alabama	Baldwin	*Acipenser oxyrhynchus desotoi*	Sturgeon, gulf	Threatened
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback sea	Endangered
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Peromyscus polionotus ammobates	Mouse, Alabama beach	Endangered
		Peromyscus polionotus trissyllepsis	Mouse, Perdido Key beach	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Pseudemys alabamensis	Turtle, Alabama red-bellied	Endangered
	Mobile	*Acipenser oxyrhynchus desotoi*	Sturgeon, gulf	Threatened
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback sea	Endangered
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Gopherus polyphemus	Tortoise, gopher	Threatened
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Pseudemys alabamensis	Turtle, Alabama red-bellied	Endangered
Arizona	Cochise	*Canis lupus*	Wolf, gray	Endangered
		Coryphantha robbinsorum	Cactus, Cochise pincushion	Threatened
		Cyprinella formosa	Shiner, beautiful	Threatened
		Falco femoralis septenrionalis	Falcon, northern aplomado	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Felis yagouaroundi tolteca	Jaguarundi	Endangered
		Gila purpurea	Chub, Yaqui	Endangered
		Grus americana	Crane, whooping	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Ictalurus pricei	Catfish, Yaqui	Threatened
		Leptonycteris curasoae yerbabuenae	Bat, lesser long-nosed	Endangered
		Poeciliopsis occidentalis	Topminnow, Gila (incl. Yaqui)	Endangered
	Maricopa	*Agave arizonica*	Agave, Arizona	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Leptonycteris curasoae yerbabuenae	Bat, lesser long-nosed	Endangered
		Meda fulgida	Spikedace	Threatened
		Poeciliopsis occidentalis	Topminnow, Gila (incl. Yaqui)	Endangered
		Purchia subintegra	Cliffrose, Arizona	Endangered
		Rallus longirostris yumenensis	Rail, Yuma clapper	Endangered
		Tumamoca macdougalli	Globe-berry, tumamoc	Endangered
	Pima	*Amsonia kearneyana*	Blue-star, Kearney's	Endangered
		Antilocapra americana peninsularis	Pronghorn, Sonoran	Threatened

continued

State	County	Scientific name	Common name	Federal status
Arizona— continued		*Colinus virginianus ridgwayi*	Bobwhite, masked	Endangered
		Cyprinodon macularius	Pupfish, desert	Endangered
		Echinocactus horizonthalonius var. *nicholii*	Cactus, Nichol's Turk's head	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Gila ditaenia	Chub, Sonoran	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Leptonycteris curasoae yerbabuenae	Bat, lesser long-nosed	Endangered
		Poeciliopsis occidentalis	Topminnow, Gila (incl. Yaqui)	Endangered
		Strix occidentalis lucida	Owl, Mexican spotted	Proposed threatened
		Tumamoca macdougalli	Globe-berry, tumamoc	Endangered
	Santa Cruz	*Canis lupus*	Wolf, gray	Endangered
		Falco femoralis septentrionalis	Falcon, northern aplomado	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Felis yagouaroundi tolteca	Jaguarundi	Endangered
		Gila ditaenia	Chub, Sonoran	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Leptonycteris curasoae yerbabuenae	Bat, lesser long-nosed	Endangered
		Meda fulgida	Spikedace	Threatened
		Poeciliopsis occidentalis	Topminnow, Gila (incl. Yaqui)	Endangered
	Pinal	*Echinocactus horizonthalonius* var. *nicholii*	Cactus, Nichol's Turk's head	Endangered
		Echinocereus troglochidiatus var. *arizonicus*	Cactus, Arizona hedgehog	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Leptonycteris curasoae yerbabuenae	Bat, lesser long-nosed	Endangered
		Meda fulgida	Spikedace	Threatened
		Poeciliopsis occidentalis	Topminnow, Gila (incl. Yaqui)	Endangered
		Rallus longirostris yumenensis	Rail, Yuma clapper	Endangered
		Tiaroga cobitis	Minnow, loach	Threatened
		Tumamoca macdougalli	Globe-berry, tumamoc	Endangered
	Yuma	*Antilocapra americana peninsularis*	Pronghorn, Sonoran	Threatened
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Leptonycteris curasoae yerbabuenae	Bat, lesser long-nosed	Endangered
		Rallus longirostris yumenensis	Rail, Yuma clapper	Endangered
California	Alameda	*Amsinckia grandiflora*	Fiddleneck, large-flowered	Endangered
		Branta canadensis leucopareia	Goose, Aleutian Canada	Threatened
		Cordylanthus palmatus	Bird's-beak, palmate-bracted	Endangered
		Euphydryas editha bayensis	Butterfly, bay checkerspot	Threatened
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Rallus longirostris obsoletus	Rail, California clapper	Endangered
		Reithrodontomys raviventris	Mouse, salt marsh harvest	Endangered

continued

State	County	Scientific name	Common name	Federal status
California— continued		*Sterna antillarum (= albifrons) browni*	Tern, California least	Endangered
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
	Contra Costa	*Apodemia mormo langei*	Butterfly, Lange's metalmark	Endangered
		Branta canadensis leucopareia	Goose, Aleutian Canada	Threatened
		Erysimum capitatum var. *angustatum*	Wallflower, Contra Costa	Endangered
		Euphydryas editha bayensis	Butterfly, bay checkerspot	Threatened
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Oenothera deltoides ssp. *howellii*	Evening-primrose, Antioch Dunes	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Rallus longirostris obsoletus	Rail, California clapper	Endangered
		Reithrodontomys raviventris	Mouse, salt marsh harvest	Endangered
		Sterna antillarum (= albifrons) browni	Tern, California least	Endangered
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
	Fresno	*Branta canadensis leucopareia*	Goose, Aleutian Canada	Endangered
		Caulanthus californicus	Jewelflower, California	Endangered
		Cordylanthus palmatus	Bird's-beak, palmate-bracted	Endangered
		Desmocerus californicus dimorphus	Beetle, valley elderberry longhorn	Threatened
		Dipodomys ingens	Rat, giant kangaroo	Endangered
		Dipodomys nitratoides exilis	Rat, Fresno kangaroo	Endangered
		Eriastrum hooveri	Woolly-star, Hoover's	Threatened
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Gambelia silus	Lizard, blunt-nosed leopard	Endangered
		Gymnogyps californianus *	Condor, California	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lembertia congdonii	Woolly-threads, San Joaquin	Endangered
		Onchorhynchus clarki henshawi	Trout, Lahontan cutthroat	Threatened
		Oncorhynchus aquabonita whitei	Trout, Little Kern golden	Threatened
		Oncorhynchus clarki seleniris	Trout, Paiute cutthroat	Threatened
		Thamnophis gigas	Snake, giant garter	Proposed endangered
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
	Imperial	*Branta canadensis leucopareia*	Goose, Aleutian Canada	Threatened
		Cyprinodon macularius	Pupfish, desert	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Gila elegans	Chub, bonytail	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Pelecanus occidentalis	Pelican, California brown	Endangered
		Rallus longirostris yumenensis	Rail, Yuma clapper	Endangered
	Kern	*Caulanthus californicus*	Jewelflower, California	Endangered
		Dipodomys ingens	Rat, giant kangaroo	Endangered
		Dipodomys nitratoides nitratoides	Rat, Tipton kangaroo	Endangered
		Eremalche kernensis	Mallow, Kern	Endangered
		Eriastrum hooveri	Woolly-star, Hoover's	Threatened
		Euproserpinus euterpe	Moth, Kern primrose sphinx	Threatened

* Species that are extirpated from the wild; reintroductions are either planned or in progress.

continued

State	County	Scientific name	Common name	Federal status
California— continued		*Falco peregrinus anatum*	Falcon, American peregrine	Endangered
		Gambelia silus	Lizard, blunt-nosed leopard	Endangered
		Gymnogyps californianus *	Condor, California	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lembertia congdonii	Woolly-threads, San Joaquin	Endangered
		Listingopherus agassizii	Tortoise, desert	Threatened
		Opuntia treleasei	Cactus, Bakersfield	Endangered
		Vireo bellii pusillus	Vireo, least Bell's	Endangered
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
	Kings	*Caulanthus californicus*	Jewelflower, California	Endangered
		Dipodomys ingens	Rat, giant kangaroo	Endangered
		Dipodomys nitratoides nitratoides	Rat, Tipton kangaroo	Endangered
		Eriastrum hooveri	Woolly-star, Hoover's	Threatened
		Gambelia silus	Lizard, blunt-nosed leopard	Endangered
		Lembertia congdonii	woolly-threads, San Joaquin	Endangered
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
	Los Angeles	*Amphispiza belli clementeae*	Sparrow, San Clemente Sage	Threatened
		Castilleja grisea	Paintbrush, San Clemente Island Indian	Endangered
		Cordylanthus maritimus ssp. *maritimus*	Bird's-beak, salt marsh	Endangered
		Delphinium kinkiense	Larkspur, San Clemente Island	Endangered
		Euphilotes battoides allyni	Butterfly, El Segundo blue	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Gasterosteus aculeatus williamsoni	Stickleback, unarmored threespine	Endangered
		Glaucopsyche lygdamus palosverdesensis	Butterfly, Palos Verde blue	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lanius ludovicianus mearnsi	Shrike, San Clemente loggerhead	Endangered
		Lotus dendroideus ssp. *traskiae* (= *L. scoparius* ssp. *t.*)	Broom, San Clemente Island	Endangered
		Malacothamnus clementinus	Bush-mallow, San Clemente Island	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Rallus longirostris levipes	Rail, light-footed clapper	Endangered
		Sterna antillarum (= *albifrons*) *browni*	Tern, California least	Endangered
		Vireo bellii pusillus	Vireo, least Bell's	Endangered
		Xantusia (= *Klauberina*) *riversiana*	Lizard, Island night	Threatened
	Orange	*Cordylanthus maritimus* ssp. *maritimus*	Bird's-beak, salt marsh	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Rallus longirostris levipes	Rail, light-footed clapper	Endangered
		Sterna antillarum (= *albifrons*) *browni*	Tern, California least	Endangered
		Vireo bellii pusillus	Vireo, least Bell's	Endangered
	Riverside	*Batrochoseps aridus*	Salamander, desert slender	Endangered
		Dipodomys stephensi (incl. *D. cascus*)	Rat, Stephens' kangaroo	Endangered
		Dodecahema leptoceras	Spineflower, slender-horned	Endangered
		Eryngium aristulatum var. *parishii*	Button-celery, San Diego	Proposed endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered

continued

State	County	Scientific name	Common name	Federal status
California— continued		*Orcuttia californica*	Grass, California Orcutt	Proposed endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Pelecanus occidentalis	Pelican, California brown	Endangered
		Pogogyne nudiuscuala	Mint, Otey Mesa	Proposed endangered
		Rallus longirostris yumenensis	Rail, Yuma clapper	Endangered
		Uma inornata	Lizard, Coachella Valley fringe-toed	Threatened
		Vireo bellii pusillus	Vireo, least Bell's	Endangered
	Sacramento	*Branta canadensis leucopareia*	Goose, Aleutian Canada	Threatened
		Desmocerus californicus dimorphus	Beetle, valley elderberry longhorn	Threatened
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Hypomesus transpacificus	Smelt, delta	Proposed threatened
		Oenothera deltoides ssp. *howellii*	Evening-primrose, Antioch Dunes	Endangered
		Thamnophis gigas	Snake, giant garter	Proposed endangered
	San Bernardino	*Astragalus albens*	Milkvetch, cushenberry	Proposed endangered
		Dodecahema leptoceras	Spineflower, slender-horned	Endangered
		Eriastrum densifolium ssp. *sanctorum*	Woolly-star, Santa Ana River	Endangered
		Erigeron parishii	Daisy, Parish's	Proposed endangered
		Eriogonum ovalifolium var. *vineum*	Buckwheat, cushenbury	Proposed endangered
		Gila bicolor mohavensis	Chub, Mohave tui	Endangered
		Gila elegans	Chub, bonytail	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lesquerella kingii ssp. *bernardina*	Bladderpod, San Bernardino Mountains	Proposed endangered
		Microtus californicus scirpensis	Vole, Amargosa	Endangered
		Oxytheca parishii var. *goodmaniana*	Oxytheca, cushenberry	Proposed endangered
		Rallus longirostris yumenensis	Rail, Yuma clapper	Endangered
		Sidalcea pedata	Checker-mallow, Pedate	Endangered
		Thelypodium stenopetalum	Mustard, slender-petaled	Endangered
		Vireo bellii pusillus	Vireo, least Bell's	Endangered
	San Diego	*Branta canadensis leucopareia*	Goose, Aleutian Canada	Threatened
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Cordylanthus maritimus ssp. *maritimus*	Bird's-beak, salt marsh	Endangered
		Dipodomys stephensi (incl. *D. cascus*)	Rat, Stephens' kangaroo	Endangered
		Eryngium aristulatum var. *parishii*	Button-celery, San Diego	Proposed endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys olivacea	Turtle, (Pacific) olive Ridley sea	Threatened
		Orcuttia californica	Grass, California Orcutt	Proposed endangered
		Pelecanus occidentalis	Pelican, brown	Endangered

continued

State	County	Scientific name	Common name	Federal status
California— continued		*Pogogyne abramsii*	Mint, San Diego Mesa	Endangered
		Pogogyne nudiuscula	Mint, Otey Mesa	Proposed endangered
		Rallus longirostris levipes	Rail, Light-footed clapper	Endangered
		Sterna antillarum (= albifrons) browni	Tern, California least	Endangered
		Streptocephalus wootoni	Shrimp, Riverside fairy	Proposed endangered
		Vireo bellii pusillus	Vireo, Least Bell's	Endangered
	San Joaquin	*Amsinckia grandiflora*	Fiddleneck, large-flowered	Endangered
		Branta canadensis leucopareia	Goose, Aleutian Canada	Threatened
		Cordylanthus palmatus	Bird's-beak, palmate-bracted	Endangered
		Desmocerus californicus dimorphus	Beetle, valley elderberry longhorn	Threatened
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Hypomesus transpacificus	Smelt, delta	Proposed threatened
		Thamnophis gigas	Snake, giant garter	Proposed endangered
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
	San Luis Obispo	*Arctostaphylos morroensis*	Manzanita, Morro	Proposed endangered
		Branta canadensis leucopareia	Goose, Aleutian Canada	Threatened
		Caulanthus californicus	Jewelflower, California	Endangered
		Circium fontinale var. *obispoense*	Bog thistle, Chorro Creek	Proposed endangered
		Clarkia speciosa spp. *immaculata*	Clarkia, Pismo	Proposed endangered
		Cordylanthus maritimus ssp. *maritimus*	Bird's-beak, salt marsh	Endangered
		Dipodomys heermanni morroensis	Rat, Morro Bay kangaroo	Endangered
		Dipodomys ingens	Rat, giant kangaroo	Endangered
		Enhydra lutris nereis	Otter, southern sea	Threatened
		Eriastrum hooveri	Woolly-star, Hoover's	Threatened
		Eriodictyon altissimum	Mountainbalm, Indian Knob	Proposed endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Gambelia silus	Lizard, blunt-nosed leopard	Endangered
		Gymnogyps californianus *	Condor, California	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Helminthoglypta walkeriana	Snail, Morro shoulderband	Proposed endangered
		Lembertia congdonii	Woolly-threads, San Joaquin	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Rallus longirostris obsoletus	Rail, California clapper	Endangered
		Sterna antillarum (= albifrons) browni	Tern, California least	Endangered

* Species that are extirpated from the wild; reintroductions are either planned or in progress.

continued

State	County	Scientific name	Common name	Federal status
California— continued		*Suaeda californica*	Sea-blite, California	Proposed endangered
		Vireo bellii pusillus	Vireo, least Bell's	Endangered
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
	San Mateo	*Acanthomintha obovata* ssp. *duttonii*	Thornmint, San Mateo	Endangered
		Callophrys mossil bayensis	Butterfly, San Bruno elfin	Endangered
		Cupressus abramsiana	Cypress, Santa Cruz	Endangered
		Euphydryas editha bayensis	Butterfly, bay checkerspot	Threatened
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Icaricia icarioides missionensis	Butterfly, Mission blue	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Rallus longirostris obsoletus	Rail, California clapper	Endangered
		Reithrodontomys raviventris	Mouse, salt marsh harvest	Endangered
		Speyeria zerene myrtleae	Butterfly, Myrtle's silverspot	Proposed endangered
		Sterna antillarum (= *albifrons*) *browni*	Tern, California least	Endangered
		Thamnophis sirtalis tetrataenia	Snake, San Francisco garter	Endangered
	Santa Barbara	*Arctocephalus townsendi*	Seal, Guadalupe fur	Threatened
		Branta canadensis leucopareia	Goose, Aleutian Canada	Threatened
		Caulanthus californicus	Jewelflower, California	Endangered
		Cordylanthus maritimus ssp. *maritimus*	Bird's-beak, salt marsh	Endangered
		Dipodomys ingens	Rat, giant kangaroo	Endangered
		Dudleya traskiae	Liveforever, Santa Barbara	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Falco peregrinus tundrius	Falcon, Arctic peregrine	Threatened
		Gambelia silus	Lizard, blunt-nosed leopard	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Layai carnosa	Layia, beach	Proposed endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Rallus longirostris levipes	Rail, light-footed clapper	Endangered
		Sterna antillarum (= *albifrons*) *browni*	Tern, California least	Endangered
		Vireo bellii pusillus	Vireo, least Bell's	Endangered
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
		Xantusia (= *Klauberina*) *riversiana*	Lizard, island night	Threatened
	Santa Clara	*Euphydryas editha bayensis*	Butterfly, bay checkerspot	Threatened
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Rallus longirostris obsoletus	Rail, California clapper	Endangered
		Reithrodontomys raviventris	Mouse, salt marsh harvest	Endangered
		Sterna antillarum (= *albifrons*) *browni*	Tern, California least	Endangered
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
	Santa Cruz	*Ambystoma macrodactylum croceum*	Salamander, Santa Cruz long-toed	Endangered
		Chorizanthe pungens var. *hartwegiana*	Spineflower, Ben Lomond	Proposed endangered

continued

State	County	Scientific name	Common name	Federal status
California— continued		*Chorizanthe pungens* var. *pungens*	Spineflower, Monterey	Proposed endangered
		Chorizanthe robusta var. *hartwegii*	Spineflower, Scotts Valley	Proposed endangered
		Chorizanthe robusta var. *robusta*	Spineflower, robust	Proposed endangered
		Cupressus abramsiana	Cypress, Santa Cruz	Endangered
		Enhydra lutris nereis	Otter, southern sea	Threatened
		Erysimum terretifolium	Santa Cruz wallflower	Proposed endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
	Tulare	*Caulanthus californicus*	Jewelflower, California	Endangered
		Dipodomys nitratoides nitratoides	Rat, Tipton kangaroo	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Gambelia silus	Lizard, blunt-nosed leopard	Endangered
		Gymnogyps californianus *	Condor, California	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lembertia congdonii	Woolly-threads, San Joaquin	Endangered
		Oncorhynchus aquabonita whitei	Trout, Little Kern golden	Threatened
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
	Ventura	*Cordylanthus maritimus* ssp. *maritimus*	Bird's-beak, salt marsh	Endangered
		Gambelia silus	Lizard, blunt-nosed leopard	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Rallus longirostris levipes	Rail, light-footed clapper	Endangered
		Sterna antillarum (= *albifrons*) *browni*	Tern, California least	Endangered
		Vireo bellii pusillus	Vireo, least Bell's	Endangered
		Vulpes macrotis mutica	Fox, San Joaquin kit	Endangered
		Xantusia (= *Klauberina*) *riversiana*	Lizard, island night	Threatened
Florida	Brevard	*Aphelocoma coerulescens coerulescens*	Jay, Florida scrub	Threatened
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback sea	Threatened
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Eretmochelys imbricata	Turtle, hawksbill sea (= carey)	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Nerodia fasciata taeniata	Snake, Atlantic salt marsh	Threatened
		Peromyscus polionotus niveiventris	Mouse, southeastern beach	Threatened
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered

* Species that are extirpated from the wild; reintroductions are either planned or in progress.

continued

State	County	Scientific name	Common name	Federal status
Florida— continued	Broward	*Caretta caretta*	Turtle, loggerhead sea	Threatened
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Crocodylus acutus	Crocodile, American	Endangered
		Dermochelys coriacea	Turtle, leatherback sea	Threatened
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Eretmochelys imbricata	Turtle, hawksbill sea (= carey)	Endangered
		Felis concolor coryi	Panther, Florida	Endangered
		Mycteria americana	Stork, wood	Endangered
		Rostrhamus sociabilis plumbeus	Kite, Everglade snail	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered
	Dade	*Ammodramus maritimus mirabilis*	Sparrow, Cape Sable seaside	Endangered
		Amorpha crenulata	Lead-plant, crenulate	Endangered
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Chamaesyce deltoides ssp. *deltoidea*	Spurge	Endangered
		Chamaesyce garberi	No common name	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Crocodylus acutus	Crocodile, American	Endangered
		Dermochelys coriacea	Turtle, leatherback sea	Threatened
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Eretmochelys imbricata	Turtle, hawksbill sea (= carey)	Endangered
		Felis concolor coryi	Panther, Florida	Endangered
		Galactia smallii	Milk-pea, Small's	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Heraclides aristodemus ponceanus	Butterfly, Schaus swallowtail	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Polygala smallii	Polygala, tiny	Endangered
		Rostrhamus sociabilis plumbeus	Kite, Everglade snail	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered
	Hillsborough	*Aphelocoma coerulescens coerulescens*	Jay, Florida scrub	Threatened
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Chrysopsis floridana	Aster, Florida golden	Endangered
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered
	Indian River	*Aphelocoma coerulescens coerulescens*	Jay, Florida scrub	Threatened
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback sea	Threatened

continued

State	County	Scientific name	Common name	Federal status
Florida— continued		*Dicerandra immaculata*	Mint, Lakela's	Endangered
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Nerodia fasciata taeniata	Snake, Atlantic salt marsh	Threatened
		Peromyscus polionotus niveiventris	Mouse, southeastern beach	Threatened
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Polyborus plancus audubonii	Caracara, Audubon's crested	Threatened
		Rostrhamus sociabilis plumbeus	Kite, Everglade snail	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered
	Lee	*Aphelocoma coerulescens coerulescens*	Jay, Florida scrub	Threatened
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Deeringothamnus pulchellus	Pawpaw, beautiful	Endangered
		Dermochelys coriacea	Turtle, leatherback sea	Threatened
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered
	Monroe	*Ammodramus maritimus mirabilis*	Sparrow, Cape Sable seaside	Endangered
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Cereus robinii	Tree-cactus, Key	Endangered
		Chamaesyce garberi	No common name	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Crocodylus acutus	Crocodile, American	Endangered
		Dermochelys coriacea	Turtle, leatherback sea	Threatened
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Eretmochelys imbricata	Turtle, hawksbill sea (= carey)	Endangered
		Felis concolor coryi	Panther, Florida	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Heraclides aristodemus ponceanus	Butterfly, Schaus swallowtail	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Neotoma floridana smalli	Woodrat, Key Largo	Endangered
		Odocoileus virginianus clavium	Deer, Key	Endangered
		Orthalicus reses (not incl. *nesodryas*)	Snail, Stock Island	Threatened
		Oryzomys palustris natator	Rat, rice	Endangered
		Peromyscus gossypinus allapaticola	Mouse, Key Largo cotton	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Sterna dougallii dougallii	Tern, roseate	Endangered
		Sylvilagus palustris hefneri	Rabbit, Lower Keys	Endangered

continued

State	County	Scientific name	Common name	Federal status
Florida— continued		*Trichechus manatus*	Manatee, West Indian	Endangered
	Orange	*Aphelocoma coerulescens coerulescens*	Jay, Florida scrub	Threatened
		Bonamia grandiflora	Bonamia, Florida	Threatened
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lupinus aridorum	Lupine, scrub	Endangered
		Mycteria americana	Stork, wood	Endangered
		Neoseps reynoldsi	Skink, sand	Threatened
		Paronychia chartaceae	Willow-wort, papery	Threatened
		Picoides borealis	Woodpecker, red-cockaded	Endangered
	Palm Beach	*Aphelocoma coerulescens coerulescens*	Jay, Florida scrub	Threatened
		Asimina tetramera	Pawpaw, four-petal	Endangered
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Cucurbita okeechobeensis	Gourd, Okeechobee	Proposed endangered
		Dermochelys coriacea	Turtle, leatherback sea	Threatened
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Eretmochelys imbricata	Turtle, hawksbill sea (= carey)	Endangered
		Felis concolor coryi	Panther, Florida	Endangered
		Mycteria americana	Stork, wood	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Rostrhamus sociabilis plumbeus	Kite, Everglade snail	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered
	Pinellas	*Caretta caretta*	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered
	Seminole	*Aphelocoma coerulescens coerulescens*	Jay, Florida scrub	Threatened
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Mycteria americana	Stork, wood	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered
	St. Lucie	*Aphelocoma coerulescens coerulescens*	Jay, Florida scrub	Threatened
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Cereus eriophorus var. *fragrans*	Prickly-apple, fragrant	Endangered

continued

State	County	Scientific name	Common name	Federal status
Florida— continued		*Charadrius melodus*	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback sea	Threatened
		Dicerandra immaculata	Mint, Lakela's	Endangered
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Eretmochelys imbricata	Turtle, hawksbill sea (= carey)	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Peromyscus polionotus niveiventris	Mouse, southeastern beach	Threatened
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Rostrhamus sociabilis plumbeus	Kite, Everglade snail	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered
Georgia	Chatham	*Acipenser brevirostrum*	Sturgeon, shortnose	Endangered
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback sea	Endangered
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Mycteria americana	Stork, wood	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Trichechus manatus	Manatee, West Indian	Endangered
Louisiana	Jefferson	*Caretta caretta*	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback sea	Endangered
		Falco peregrinus tundrius	Falcon, Arctic peregrine	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Scaphirhynchus albus	Sturgeon, pallid	Endangered
	Lafourche	*Caretta caretta*	Turtle, loggerhead sea	Threatened
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback	Endangered
		Falco peregrinus tundrius	Falcon, Arctic peregrine	Threatened
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
	Orleans	*Acipenser oxyrhynchus desotoi*	Sturgeon, gulf	Threatened
		Falco peregrinus tundrius	Falcon, Arctic peregrine	Threatened
		Pelecanus occidentalis	Pelican, brown	Endangered
		Scaphirhynchus albus	Sturgeon, pallid	Endangered

continued

State	County	Scientific name	Common name	Federal status
Louisiana— continued	Plaquemines	*Caretta caretta*	Turtle, loggerhead sea	Threatened
		Caradrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback	Endangered
		Falco peregrinus tundrius	Falcon, Arctic peregrine	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Scaphirhynchus albus	Sturgeon, pallid	Endangered
	St. Bernard	*Caretta caretta*	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback	Endangered
		Falco peregrinus tundrius	Falcon, Arctic peregrine	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Scaphirhynchus albus	Sturgeon, pallid	Endangered
	St. Charles	*Falco peregrinus tundrius*	Falcon, Arctic peregrine	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Scaphirhynchus albus	Sturgeon, pallid	Endangered
Mississippi	Harrison	*Acipenser oxyrhynchus desotoi*	Sturgeon, gulf	Threatened
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Dermochelys coriacea	Turtle, leatherback	Endangered
		Drymarchon corais couperi	Snake, eastern indigo	Threatened
		Gopherus polyphemus	Tortoise, gopher	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Ursus americanus luteolus	Bear, Louisiana black	Threatened
South Carolina	Beaufort	*Acipenser brevirostrum*	Sturgeon, shortnose	Endangered
		Caretta caretta	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lindera melissifolia	Pondberry	Endangered
		Mycteria americana	Stork, wood	Endangered
		Oxypolis canbyi	Dropwort, Canby's	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
	Charleston	*Acipenser brevirostrum*	Sturgeon, shortnose	Endangered
		Canis rufus	Wolf, red	Endangered

continued

State	County	Scientific name	Common name	Federal status
South Carolina— continued		*Caretta caretta*	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lindera melissifolia	Pondberry	Endangered
		Mycteria americana	Stork, wood	Endangered
		Oxypolis canbyi	Dropwort, Canby's	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
		Vermivora bachmanii	Warbler (wood), Bachman's	Endangered
Texas	Cameron	*Caretta caretta*	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Eretmochelys imbricata	Turtle, hawksbill sea (= carey)	Endangered
		Falco femoralis septentrionalis	Falcon, northern aplomado	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Falco peregrinus tundrius	Falcon, Arctic peregrine	Threatened
		Felis paradalis	Ocelot	Endangered
		Felis yagouaroundi cacomitli	Jaguarundi	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered
	Harris	*Bufo houstonensis*	Toad, Houston	Endangered
		Falco peregrinus tundrius	Falcon, Arctic peregrine	Threatened
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Hymenoxys texana	Dawn-flower, Texas prairie	Endangered
		Picoides borealis	Woodpecker, red-cockaded	Endangered
	Hidalgo	*Falco femoralis septentrionalis*	Falcon, northern aplomado	Endangered
		Felis paradalis	Ocelot	Endangered
		Felis yagouaroundi cacomitli	Jaguarundi	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Manihot walkeri	Manioc, Walker's	Endangered
	Starr	*Felis paradalis*	Ocelot	Endangered
		Felis yagouaroundi cacomitli	Jaguarundi	Endangered
		Frankenia johnstonii	Frankenia, Johnston's	Endangered
		Sterna antillarum	Tern, interior least	Endangered
		Thymophylla tephroleuca	Dogweed, ashy	Endangered
	Willacy	*Caretta caretta*	Turtle, loggerhead sea	Threatened
		Charadrius melodus	Plover, piping	Endangered
		Chelonia mydas (incl. *agassizii*)	Turtle, green sea	Threatened
		Eretmochelys imbricata	Turtle, hawksbill sea (= carey)	Endangered
		Falco femoralis septentrionalis	Falcon, northern aplomado	Endangered
		Falco peregrinus anatum	Falcon, American peregrine	Endangered
		Falco peregrinus tundrius	Falcon, Arctic peregrine	Threatened
		Felis paradalis	Ocelot	Endangered
		Felis yagouaroundi cacomitli	Jaguarundi	Endangered
		Haliaeetus leucocephalus	Eagle, bald	Endangered
		Lepidochelys kempii	Turtle, Kemp's (= Atlantic) ridley sea	Endangered
		Numenius borealis	Curlew, Eskimo	Endangered
		Pelecanus occidentalis	Pelican, brown	Endangered

Appendix C. Preparers

Animal and Plant Health Inspection Service (APHIS)
Biotechnology, Biologics, and Environmental Protection
Environmental Analysis and Documentation

Harold T. Smith
Environmental Protection Officer
B.S. Microbiology
M.A. Biology

Background: Branch Chief, Plant Pest Management Impact Analysis Branch. Nineteen years service with the Animal and Plant Health Inspection Service in positions involving pest exclusion, pest control, regulatory activities, and environmental protection. Experience coordinating and preparing environmental documents for other major APHIS programs.

EIS Responsibility: Environmental Impact Statement (EIS) Coordinator – overall responsibility for the EIS, coordination of supportive analysis efforts, and management of the interdisciplinary EIS team.

Jack Edmundson
Environmental Protection Officer
B.S. Biology
M.S. Biology

Background: Branch Chief, Environmental Analyses and Technical Services. Nineteen years experience in wildlife and contaminants issues.

EIS Responsibility: Supportive Risk Analysis Coordinator – responsibility for coordination and management of supportive risk analyses; compliance with the Endangered Species Act.

Linda Abbott
Ecologist
B.S. Biology
M.S. Environmental Biology
Ph.D. Biology / Ecology

Background: Systems ecology and limnology.

EIS Responsibility: Environmental fate and transport modeling for the Nontarget Risk Assessment and the Human Health Risk Assessment; contributed to sections of chapters I (biological resources), V (physical environment and biological resources), VII (monitoring), and to the Nontarget Risk Assessment and Human Health Risk Assessment.

David A. Bergsten
Toxicologist
B.S. Environmental Science
M.S. Entomology
M.P.H. Disease Control
Ph.D. Toxicology

Background: Expertise in pesticide research and environmental toxicology.

EIS Responsibility: Managed and wrote sections of chapters III and IV; wrote sections of chapter V, VI, and appendix A; and contributed to the Human Health Risk Assessment and the Nontarget Risk Assessment.

Karen A. Blakney
Ecologist
B.A. Zoology
M.S. Biology / Ecology

Background: Expertise in ecological risk assessment, environmental effects analysis, and general ecology.

EIS Responsibility: Managed the Nontarget Risk Assessment and managed and wrote sections of chapters IV and V (biological resources).

Charles L. Divan
Microbial Ecologist
B.S. Bacteriology
Ph.D. Environmental Microbiology

Background: Expertise in environmental microbiology and molecular biology.

EIS Responsibility: Contributed to chapter III sections on biotechnology control, control methods, and nonchemical control.

Michael J. Firko
Ecologist
B.S. Biology
Ph.D. Biology / Ecology

Background: Twelve years research on insect biology. Four years with USDA's Agricultural Research Service conducting research on population biology of insect pests, quantitative genetics of insecticide resistance, and postharvest disinfestation of fruit flies.

EIS Responsibility: Terrestrial exposure modeling for the Nontarget Risk Assessment; contributed to chapter III on biocontrol, biotechnology, male annihilation, and scenarios; and chapter V, biological resources.

Michael Green
Ecologist
A.B. Zoology
Ph.D. Biology

Background: Avian ecology, animal behavior, and general ecology.

EIS Responsibility: Contributed to chapters IV and V (biological resources) and to the Nontarget Risk Assessment; provided analysis of issues on birds; and evaluated the potential effects of methyl bromide, male annihilation, and integrated pest management on nontarget species.

Sherry Lowe
Writer/Editor

Background: Eighteen years with USDA's Agricultural Research Service, including 7 years as managing editor with the Family Economics Research Group. Experience with environmental documents and government standards for format, design, style, and desktop publishing of documents.

EIS Responsibility: Edited, formatted, and desktop published appendices B, E, F, and G.

Ronald R. McClendon
Wildlife Biologist
B.S. Wildlife Management
M.S. Biology

Background: Analysis of APHIS actions on nontarget wildlife species, including nonprotected endemic and legally protected wildlife species.

EIS Responsibilities: Provided data base of federally listed endangered and threatened species for the potential Medfly program areas.

Leslie Rubin
Toxicologist
B.A. Biology
M.S. Animal Physiology

Background: Expertis in physiology, toxicology, and food safety. Experience performing risk assessments for U.S. Environmental Protection Agency and USDA's Food Safety and Inspection Service and APHIS, and for National Environmental Policy Act documentation.

EIS Responsiblity: Managed the Human Health Risk Assessment and managed and wrote sections of chapter V (human health).

William Schroeder
Chemist
B.S. Chemistry

Background: Experience with USDA's Agricultural Research Service conducting research on natural occurring toxins in plants. Experience with the U.S. Environmental Protection Agency updating chemical analytical methods for environmental pollutants in sediments and marine tissue.

EIS Responsibility: Provided peer review of the EIS with special emphasis on chemical hypersensitivity issues.

Susan-Marie Stedman
Ecologist
B.S. Marine Biology / Geology
M.S. Coastal Geology

Background: Expertise in wetlands, coastal and estuarine environments, sediments, and general ecology. Experience in wetlands assessment and National Environmental Policy Act documentation.

EIS Responsibility: Aquatic exposure assessment for the Nontarget Risk Assessment; wrote sections of chapters IV and V (socioeconomics and biological resources) and contributed to the Nontarget Risk Assessment.

Brian Sterk
Cartographer/Illustrator
B.A. Geography

Background: Map development using geographical information systems. Cartographer/illustrator for Environmental Analysis and Documentation.

EIS Responsibility: Developed maps and figures for the EIS.

Alan V. Tasker
Agronomist
B.S. Agriculture
M.S. Agronomy
Ph.D. Agronomy

Background: Experience in agronomy, agricultural biology, weed science, pesticide research and registration, and hazardous wastes.

EIS Responsibility: Managed and wrote sections of chapter IV (land resources and characteristics) and wrote sections of chapter V.

Vicki Wickheiser
Writer/Editor

Background: Seventeen years service in APHIS, including work with the Animal Welfare and Horse Protection Acts and with information resources management. Experience in newsletter development, desktop publishing, and project planning and management.

EIS Responsibility: Overall responsibility for desktop publishing of the EIS (including editing, format, and document security); and supportive coordination and planning.

Animal and Plant Health Inspection Service
Biotechnology, Biologics, and Environmental Protection
Technical and Scientific Services

Warren Eastland
Biological Scientist
B.S. Wildlife Resources
M.S. Wildlife Science
Ph.D. Wildlife Management

Background: Expertise in range, forestry, and wildlife management; and terrestrial vertebrate ecology.

EIS Responsibility: Wrote sections of chapters IV and V (endangered and threatened species) and managed the Biological Assessment for the Medfly Cooperative Eradication Program.

Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Biological Assessment and Taxonomic Support

Kenneth Lakin
Agriculturalist
B.S. Zoology
M.S. Entomology
Ph.D. Entomology

Background: Branch Chief, Pest Risk Assessment Branch. Experience with biological control agents, insect behavior, insect pollinators, and rearing of insects.

EIS Responsibilities: Contributed to chapters III and V (biological control).

Animal and Plant Health Inspection Service
Legislative and Public Affairs
Media Services

Laurie Smith
Photographer

Background: Three years service in APHIS as a photographer/media specialist. Prior experience as a photographer with the El Paso Herald-Post, United Press International, and the American Red Cross.

EIS Responsibility: Reviewed and coordinated Departmental clearance of photographs used in the EIS.

Appendix D. Cooperation, Review, and Consultation

The following individuals have cooperated in the development of this environmental impact statement (EIS), were consulted on critical issues that have been addressed in this EIS, or reviewed draft sections of the EIS. The expertise and concerns of these individuals were considered during the development of this EIS; the content of the EIS does not necessarily reflect their individual views and opinions.

Principal Federal and State Cooperators

Jack D. Coley	Director and State Entomologist Mississippi Department of Agriculture and Commerce, Division of Plant Industry P.O. Box 5207 Mississippi State, MS 39762
Ron Conley	Assistant Commissioner Georgia Department of Agriculture Entomology and Pesticides Division Capitol Square Atlanta, GA 30334-2001
Jesus Cota	Assistant Director USDA, Forest Service, Forest Pest Management, AB-2S 201 14th Street, SW. Washington, DC 20250
Robert Dowell	Primary State Entomologist California Department of Food and Agriculture 1220 N Street, P.O. Box 942871 Sacramento, CA 94271-0001
Ken Glenn	Plant Industry Supervisor Clemson University Department of Plant Industry 112 Agricultural Servicenter Box 340392 Clemson, SC 29634-0392

Tad N. Hardy	Administrative Coordinator, Quarantine Program Louisiana Department of Agriculture and Forestry, Office of Agriculture and Environmental Sciences P.O. Box 3118 Baton Rouge, LA 70821-3118
Guy W. Karr	Plant Pest Administrator Alabama Department of Agriculture and Industries P.O. Box 3336 Montgomery, AL 36193
Shashank Nilakhe	Director, Agri-Systems Programs Texas Department of Agriculture P.O. Box 12847 Austin, TX 78711
Richard Ridgway	Research Entomologist USDA, ARS, Insect Biocontrol Laboratory Plant Sciences Institute Room 108, Building 402, BARC East Beltsville, MD 20705
Connie Riherd	Assistant Director Florida Department of Agriculture and Consumer Services Division of Plant Industry P.O. Box 147100 Gainesville, FL 32614-7100
James Serfis	Federal Activities Liaison U.S. Environmental Protection Agency Office of Federal Activities 401 M Street, SW. Mail Stop A-104 Washington, DC 20460
Larry Stanford	Assistant Director Arizona Department of Agriculture 1688 West Adams Phoenix, AZ 85007

Reviewers

Charles Bare	Staff Officer USDA, APHIS, Policy and Program Development 6505 Belcrest Road Hyattsville, MD 20782
Carl Bausch	Deputy Director USDA, APHIS, Biotechnology, Biologics, and Environmental Protection Environmental Analysis and Documentation 6505 Belcrest Road, Room 828 Hyattsville, MD 20782
Velma Charles-Shannon	Staff Toxicologist USDA, Forest Service, Forest Pest Management, AB-2S 201 14th Street, SW. Washington, DC 20250
Milton Holmes	Senior Operations Officer USDA, APHIS, Plant Protection and Quarantine Domestic and Emergency Operations 6505 Belcrest Road Hyattsville, MD 20782
May Inscoe	Chemist USDA, ARS, Insect Biocontrol Laboratory Plant Sciences Institute Room 108, Building 402, BARC East Beltsville, MD 20705
Peter Joseph	Deputy Director USDA, APHIS, Biotechnology, Biologics, and Environmental Protection Technical and Scientific Services 6505 Belcrest Road Hyattsville, MD 20782
Ken Knauer	(formerly) Assistant Director USDA, Forest Service, Forest Pest Management, AB-2S 201 14th Street, SW. Washington, DC 20250

Tsu Hui Lin

Biological Scientist
USDA, APHIS, Biotechnology, Biologics, and Environmental Protection
Technical and Scientific Services
6505 Belcrest Road
Hyattsville, MD 20782

C. Edward Miller

Senior Entomologist
USDA, APHIS, Policy and Program Development
Planning and Risk Analysis Systems
6505 Belcrest Road
Hyattsville, MD 20782

Robert Schall

(formerly) Staff Officer
USDA, APHIS, Plant Protection and Quarantine
Domestic and Emergency Operations
6505 Belcrest Road
Hyattsville, MD 20782

Robert Spaide

Operations Officer
USDA, APHIS, Plant Protection and Quarantine, Planning and Design
6505 Belcrest Road
Hyattsville, MD 20782

Mike Stefan

Operations Officer
USDA, APHIS, Plant Protection and Quarantine
Domestic and Emergency Operations
6505 Belcrest Road
Hyattsville, MD 20782

Persons Consulted

John Byrne

U.S. Department of the Interior
National Park Service
Department of Historic Preservation
Mail Stop 413, P.O. Box 37127
Washington, DC 20013-7127

James Carey

Associate Professor
Department of Entomology
University CA
Davis, CA 95616

James Coppedge	National Program Leader for Applied Entomology USDA, ARS, National Program Staff Building 005, BARC West Beltsville, MD 20705
Roy Cunningham	Research Entomologist USDA, ARS Hilo, HI 96720
William Dunson	Professor Biology Department Pennsylvania State University University Park, PA 18902
Kenneth Kaneshiro	Professor Department of Entomology University of Hawaii Honolulu, HI 96822
James Lindegren	Research Entomologist USDA, ARS Fresno, CA 93727
Robert Mangan	Research Entomologist USDA, ARS Weslaco, TX 78596
Ralph Morgenweck	Assistant for Fish and Wildlife Enhancement U.S. Department of the Interior Fish and Wildlife Service 1849 C Street, NW. Washington, DC 20240
Ronald Prokopy	Professor Department of Entomology University of Massachusetts Amherst, MA 01003
Latimore M. Smith	Louisiana Natural Heritage Program Louisiana Department of Wildlife and Fisheries Box 9800 Baton Rouge, LA 70898

James Stratton	Public Health Medical Officer California Department of Health Services P.O. Box 942732 Sacramento, CA 94234-7320
Trang Vo	Supervisory Economist USDA, APHIS, Policy and Program Development Policy Analysis and Development 6505 Belcrest Road Hyattsville, MD 20782

Appendix E. Distribution List

Stuart Adrian
USDA, APHIS, PPQ
4320 East Broadway
Phoenix, AZ 85040

R. O. Akins
Officer in Charge
USDA, APHIS, PPQ
3029 Lake Alfred Road
Winter Haven, FL 33881

Robert Amato
Assistant Executive Secretary
National Association of State Departments of Agriculture
1156 15th Street, NW., Suite 1020
Washington, DC 20005

Mary Ambrose
Manager
State of Texas, Texas Water Commission
Groundwater Conservation Section
8900 Shoal Creek Annex, Room 327
Austin, TX 78758

Director
American Farm Bureau Federation
Commodity and Marketing Division
225 Touhy Avenue
Park Ridge, IL 60068

Ing. Gonzalo Andrade
Agricultural Counselor
Embassy of Mexico
2829 16th Street, NW.
Washington, DC 20009

Mr. Chris Angelo
10877 Wilshire Blvd., Suite 600
Los Angeles, CA 90024

Mr. Pat Anson
3605 Rosemary Avenue
Glendale, CA 91208

Ehud Udi Ariav
President
Ehud Ariav Ent., Incorporated
2250 Lorie Lane
Yuma, AZ 85365

David Armstrong
41 Vicente Terrace, No. B
Santa Monica, CA 90401

David Armstrong
Random Lengths
Box 731
San Pedro, CA 90733

Helen Arnoff
8921 Southbourne
Huntington Beach, CA 92646

Alvin Ashorn
Director
State of Texas
Department of Agriculture and Environmental Sciences, Nursery and Floral Division
Box 12847, Capitol Station
Austin, TX 78711

Marty Asolas
16613 Orchard Avenue
Bellflower, CA 90706

Dr. John T. Atwood
Director
Marie Selby Botanical Gardens
Orchid Identification Center
811 South Palm Avenue
Sarasota, FL 34236

Reid and Sandra Bailey
14702 Monroe Street
Midway City, CA 92655

Mr. Brian Baker
California Certified Organic Farmers
303 Potrero, Suite 51
Santa Cruz, CA 95060

John Baker
330 South New Hampshire, No. 25
Los Angeles, CA 90020

Robin R. Barbosa
Supervisory PPQ Officer
USDA, APHIS, PPQ
9580 Micron Avenue, Suite I
Sacramento, CA 95827

Bill Barclay
Greenpeace
1436 U Street, NW.
Washington, DC 20009

Charles Bare
Staff Officer
USDA, APHIS, PPD
6505 Belcrest Road, Room 863
Hyattsville, MD 20782

Mr. Michael Bean
Environmental Defense Fund
1875 Connecticut Ave., NW.
Washington, DC 20009

Carlos Bejarano
PPQ Officer
USDA, APHIS, PPQ
Box 24249
Phoenix, AZ 85074

V. D. Belcher
PPQ Officer
USDA, APHIS, PPQ
Box 1829
Harlingen, TX 78551

Jane Besen
1540 Arriba Drive
Monterey Park, CA 91754

Doug Bournique
Executive Vice President
Indian River Citrus League
Box 519
Vero Beach, FL 32961

D. A. Brady
763 West 33rd Street
Hialeah, FL 33012

Katrina Brandon
World Wildlife Fund
1250 24th Street, NW.
Washington, DC 20037

Thomas D. Breazeal
Mayor
City of Temple City
9701 Las Tunas Drive, Box 668
Temple City, CA 91780-0668

Lura L. Brown
5102 North Fratus Drive
Temple City, CA 91780

Joseph P. Brown
State of California
Department of Health Services
2151 Republic Way
Berkeley, CA 94704

Dean Buchinger
Box 4537
Blue Jay, CA 92317

Barbara Buck
Director of Public Relations
Western Growers Association
Box 2130
Newport Beach, CA 92658

Meg Bundick
4450 Beauvais Avenue
Los Angeles, CA 90065

Cindy Burd
PPQ Officer
USDA, APHIS, PPQ
San Jose International Airport
1391 Airport Boulevard
San Jose, CA 95110

Doug Burrows
837 Traction Avenue, No. 102
Los Angeles, CA 90013

Donna E. Butnik
2343 33rd Street
Santa Monica, CA 90405-2101

Edgar R. Butts
President
E. R. Butts International, Incorporated
555 Clinton Avenue
Bridgeport, CT 06605-0337

John Byrne
U.S. Department of the Interior
National Park Service
Department of Historic Preservation
Mail Stop 413, P.O. Box 37127
Washington, DC 20013-7127

Pam Byrne
USDA, APHIS, R&D
Professional Development Center
7340 Executive Way, Suite A
Frederick, MD 21701

Bruce Calhoun
Save the Rainforest, Incorporated
604 Jamie Street
Dodgeville, WI 53533

Director
California Chamber of Commerce
Box 1736
Sacramento, CA 95808

California Farm Bureau Federation
1601 Exposition Boulevard
Sacramento, CA 95817

California Grape and Tree Fruit League
1540 East Shaw Avenue, Suite 120
Fresno, CA 93710

James Carey
Associate Professor
Department of Entomology
University of California
Davis, CA 95616

Joann Carrabbio
26201 South Vermont, No. 304-B
Harbor City, CA 90710

Roger Carrick and Elwin Heller
555 S. Flower Street, 25th Floor
Los Angeles, CA 90071

Mark Casady
2217 F Street, Suite G
Bakersfield, CA 93301

Refugio Ceballos
526 Crane Boulevard
Mt. Washington, CA 90065

J. Peter Chaires
Executive Assistant
Florida Gift Fruit Shippers Association
521 North Kirkman Road
Orlando, FL 32808-7645

Debra S. Chalot
State of Florida
Department of Agriculture and
Consumer Services
13603 Old Cutler Road
Miami, FL 33158

Dr. Velma Charles-Shannon
Staff Toxicologist
U.S. Department of Agriculture
Forest Service, FPM, AB-2S
201 14th Street, SW.
Washington, DC 20250

Whit Chase
Special Assistant to Senator Graham
United States Senate
Box 1826
Sanford, FL 32772

Lucinda Chipperoneri
Executive Officer
State of California
Department of Food and Agriculture
1220 N Street, P.O. Box 942871
Sacramento, CA 94271-0001

Carl C. Christensen
1612 Kamole Street
Honolulu, HI 96821

Jack Christensen
California Association of Nurserymen
16000 Sanborn Road
Saratoga, CA 95070

Judy Chu
Mayor, City of Monterey Park
320 West Newmark Avenue
Monterey Park, CA 91754

Citrus Grower Associates, Incorporated
2930 Winter Lake Road
Lakeland, FL 33801

Albert W. Cobb
2160 Century Park East, No. 204-N
Los Angeles, CA 90067

Mr. Rick Cole
Mayor of Pasadena
100 N. Garfield Avenue, Rm. 237
Pasadena, CA 91109-7215

Mr. Jack D. Coley
Director and State Entomologist
Mississippi Department of Agriculture and
Commerce, Division of Plant Industry
P.O. Box 5207
Mississippi State, MS 39762

William Collier
American Statesman
Box 670
Austin, TX 78767

Gobierno de Colombia
Ministry of Agriculture
Bogota Calle 38, 861
P.O. Box AA 3831
APO Miami, FL 34003

Converse B. Cone
30 Sandollar Road
Hilton Head Island, SC 29928

Mrs. Dallas S. Cone, Jr.
Box 365
Ridge Spring, SC 29129

Mr. Ron Conley
Assistant Commissioner
Georgia Department of Agriculture
Entomology and Pesticides Division
Capitol Square
Atlanta, GA 30334-2001

Mrs. Thomas Cooke
4337 North La Granada Way
La Canada, CA 91011

J. A. Cooper
Box 5190
Santa Monica, CA 90405-0190

James Coppedge
USDA, ARS, National Program Staff
Applied Entomology
Building 005, BARC West
Beltsville, MD 20705

Dr. Jesus Cota
Assistant Director
USDA, Forest Service, FPM, AB-2S
201 14th Street, SW.
Washington, DC 20250

Bob Crawford
Commissioner
State of Florida, Department of Agriculture and Consumer Services
P.O. Box 147100
Gainesville, FL 32614-7100

Kenneth Creason
President
Fillmore-Piru Citrus Association
Box 635
Fillmore, CA 93015

Kate Crespi
South Coast AQMD
9300 Flair Drive
El Monte, CA 91731

Dr. Martha Crump
University of Florida
Department of Zoology
223 Bartram Hall
Gainesville, FL 32611

Ruth V. Cubbage
4412 Palo Verde Avenue
Lakewood, CA 90713

Roy Cunningham
Research Entomologist
USDA, ARS
1158 Heauka Place
Hilo, HI 96720

Phillip Cutler
Orange County Citizens Against Malathion Spraying
3290 Turlock Drive
Costa Mesa, CA 92626

Donald L. Dahlsten
University of California
Division of Biological Control
929 Modoc Street
Berkeley, CA 94707

Colonel Dan Dansford
State of Florida
Game and Fresh Water Fish Commission
620 South Meridian Street
Tallahassee, FL 32399-1600

Janet Dauble
Exeuctive Director
Share, Care and Prayer, Incorporated
Box 2080
Frazier Park, CA 93225

J. L. Davidson
Officer in Charge
USDA, APHIS, PPQ
3505 Boca Chica Boulevard, Suite 321
Brownsville, TX 78521-4065

Bobby Davis
State of Texas, Department of Health
Environment and Consumer Health Protection Projects
1100 West 49th Street
Austin, TX 78756-7111

David Davis
Coordinator
State of Texas, Department of Agriculture
Plant Quality Programs
Box 12847
Austin, TX 78711

Robert M. Davis
USDA, APHIS, PPQ
3505 Boca Chica Boulevard, Suite 360
Brownsville, TX 78520

Eleanor Dawes
Consortium for International Crop Protection
4321 Hartwick Road, Suite 404
College Park, MD 20740

Peter Demetriou
KFWB-TV
6230 Yucca Street
Hollywood, CA 90028

Janice E. Derby
Route 10, Box 27-C
Hagerstown, MD 21740

C. R. Dewhurst
Mayor, City of Miami Springs
Miami Springs, FL 33166

Dr. Michael J. DiBartolomeis
State of California
Department of Health Services
2151 Berkeley Way, Room 619
Berkeley, CA 94704

Joanne DiVito
Action NOW
928 East San Jose
Burbank, CA 91501

Everett J. Dietrick
962 Poli Street
Ventura, CA 93001

Everett J. Dietrick
President and Registered Entomologist
Rincon-Vitova Insectaries, Incorporated
P.O. Box 95
Oakview, CA 93022

Vic Dinnerstein
3729 Cahuenga Boulevard, West
Studio City, CA 91604

Dr. Robert Dowell
Primary State Entomologist
California Department of Food and Agriculture
1220 N Street, P.O. Box 942871
Sacramento, CA 94271-0001

Mrs. Karry Dressler
Route 2, Box 565-C
Micanopy, FL 32667

Susan Dudasik
9910 Wheatland Avenue
Sunland, CA 91040

Ashley Dunn
Los Angeles Times
Times Mirror Square
Los Angeles, CA 90012

Marle Dunn
KCBS-TV
6121 Sunset Boulevard
Hollywood, CA 90028

William Dunson
Professor
Biology Department
Pennsylvania State University
University Park, PA 18902

Mary Duprey
420 Pico Boulevard, No. 102
Santa Monica, CA 90405

Michael V. Durando
President
California Grape and Tree Fruit League
1540 East Shaw Avenue, Suite 120
Fresno, CA 93710

Jonathan K. Dysart
134½ South Orange Avenue
Brea, CA 92621

Christine East
1414 East 13th Street, No. 7
Cheyenne, WY 82001

A. S. Elder
Regional Director
USDA, APHIS, PPQ-SER
3505 25th Avenue
Building 1, North
Gulfport, MS 39501

Lee F. Emerson
Conservation Chair
Sierra Club
Miami Group
Box 43-0741
South Miami, FL 33243-0741

Dr. Thomas C. Emmel
University of Florida
Department of Zoology
223 Bartram Hall
Gainesville, FL 32611

Paul B. Engler
Executive Secretary
California Citrus Quality Council
953 West Foothill Boulevard
Claremont, CA 91711

Terry English
Special Agent
U.S. Department of the Interior
Fish and Wildlife Service
10426 NW., 31 Terrace
Miami, FL 33172

Gary Ernsdorff
1508 10th Avenue East, No. 403
Seattle, WA 98102

Nathan Erwin
Entomologist
Rachel Carson Council
8940 Jones Mill Road
Chevy Chase, MD 20815

Dr. Arthur Evans
The Insect Zoo
Natural History Museum
900 Exposition Blvd.
Los Angeles, CA 90007

David Fadwick
555 South Flower Street, 25th Floor
Los Angeles, CA 90071

Nicholas Fairrie
Fine Works of Art
408 North Doheny, No. 6
Los Angeles, CA 90048

Dr. Don Farst
Rio Grande Valley Zoological Society
Gladys Porter Zoo
500 Ringgold
Brownsville, TX 78520

Dr. Peter Feinsinger
University of Florida
Department of Zoology
223 Bartram Hall
Gainesville, FL 32611

The Honorable Dianne Feinstein
United States Senate
Washington, DC 20510

Lynn Fischer
Natural Resources Defense Council, Inc.
1350 New York Avenue, NW., Suite 300
Washington, DC 20005

Florida Citrus Mutual
Box 89
Lakeland, FL 33802

Florida Fruit and Vegetable Association
4401 East Colonial Drive
Orlando, FL 32814

Kenneth T. Fong
Attorney
Barbosa & Vera
Attorneys at Law
1000 Corporate Center Drive, Suite 350
Monterey Park, CA 91754

Larry Fowler
PPQ Officer
USDA, APHIS, PPQ
Border Svcs Building
1500 E. Elizabeth Sreet, Room 224
Brownsville, TX 78520

Mr. Michael Friedman
Suite 3100
2049 Century Park E.
Los Angeles, CA 90067-3272

Friends of the Earth
Northwest Office Branch
4512 University Way, NE.
Seattle, WA 98105

Beth Fujishige
Administrative Assistant
City of Monterey Park
320 West Newmark Avenue
Monterey Park, CA 91754

Randall J. Fullerton
Vice President
Families Opposed to Chemical Urban Spraying
4741 Clybourne, No. 4
North Hollywood, CA 91602

Janice Gabhart
P.O. Box 80414
San Marino, CA 91118

P. Galbreath
President
97th Street Block Club
930 East 97th Street
Los Angeles, CA 90002

David Garcia
KNBC-TV
2000 West Alameda
Burbank, CA 91505

Phil Garcia
Associate Regional Director, Area III
USDA, APHIS, PPQ
3505 Boca Chica Boulevard, Suite 321
Brownsville, TX 78521-4065

Richard Garcia
Division of Biological Control
University of California
1050 San Pablo Avenue
Albany, CA 94706

Peter Garrow
KNBC-TV
2000 West Alameda
Burbank, CA 91506

Richard Gaskalla
Director
State of Florida
Department of Agriculture and Consumer Services, Division of Plant Industry
Box 147100
Gainesville, FL 32614-7100

Johanne Gaudioso
City of Los Angeles
Office of Chief Legislative Analyst
200 North Spring Street
Los Angeles, CA 90012

Pamela P. Gehrts
4149 Lomina Avenue
Lakewood, CA 90713

Gary Gero
City of Los Angeles
Environmental Affairs Department
200 North Spring Street, Room 2403, M-S. 177
Los Angeles, CA 90012

Dr. Leslie Gerson
Veterinarian
Gerson Animal Hospital
9 Westward Drive
Miami Springs, FL 33166

Henry L. Giclas
Western Growers Association
Vegetable Growers Division
3120 North 19th Avenue, Suite 190
Phoenix, AZ 85015

Susan Gill
Pasadena Star News
525 E. Colorado
Pasadena, CA 90019

Mr. Ken Glenn
Plant Industry Supervisor
Department of Plant Industry
Clemson University
112 Agricultural Servicenter
Box 340392
Clemson, SC 29634-0392

Don Goetz
6321 NW. 38th Terrace
Virginia Gardens, FL 33166

Bonnie Goldfarb
20652 Pacific Coast Highway
Malibu, CA 90265

Patrick Gomes
Staff Officer
USDA, APHIS, IS, OS
6505 Belcrest Road, Rm. 657
Hyattsville, MD 20782

Mr. Ken Gordon
Mississippi Department of Wildlife,
Fisheries, and Parks
Museum of Natural Science
111 North Jefferson Street
Jackson, MS 39201

Dr. Laurie Greenberg
University of Wisconsin
Department of Geography
Madison, WI 57306

Dr. Russel Greenberg
National Zoological Park
Migratory Bird Center
3001 Connecticut Avenue, NW.
Washington, DC 20008

Barbara Greenstein
745 Westhulme
Los Angeles, CA 90024

Penny Grego
KCBS-TV
6121 Sunset Boulevard
Hollywood, CA 90028

Norma Grier
Executive Director
Northwest Coalition for Alternatives to
Pesticides
Box 1393
Eugene, OR 97440

J. T. Griffiths
Managing Director
Citrus Grower Associates, Incorporated
2930 Winter Lake Road
Lakeland, FL 33801

Jan E. Groot
Chairman
California Association of Nurserymen
Legislative and Regulatory Committee
1419 21st Street
Sacramento, CA 95814

Joel Grossman
937 6th Street, No. 5
Santo Monica, CA 90403

Gobierno de Guatemala
Ministry of Agriculture, Livestock, and Food
Division Agri. Service (DIGESA)
Plant Health Service (DGSV)
7-01 Abenida de la Reforma - Zone 10
APO Miami, FL 34024

Dianne C. Gutierrez
Officer in Charge
USDA, APHIS, PPQ
Drawer R
Hidalgo, TX 78557

Maurie Haas
President
Frontera Audubon Society
301 South Border Avenue
Weslaco, TX 78596

Kenneth Hagen
Division of Biological Control
University of California
1050 San Pablo Avenue
Albany, CA 94706

James Hahn
City Attorney
City of Los Angeles
1800 City Hall East
Los Angeles, CA 90012

Harold Halpern
4558 Willis Avenue, No. 113
Sherman Oaks, CA 91403

Gary Halvorson
U.S. Department of the Interior
Fish and Wildlife Service
P.O. Box 1306
Albuquerque, NM 87103

Patrick R. Hamilton
Senior Vice President
Lykes Brothers, Incorporated
Southern Operating Division
Agricultural Operations Section
106 SW. CR 721
Okeechobee, FL 34974-8918

Mr. Tad N. Hardy
Administrative Coordinator
Quarantine Program, Louisiana Department of Agriculture and Forestry
Office of Agriculture & Environmental Sciences
P.O. Box 3118
Baton Rouge, LA 70821-3118

Mr. T. M. Harris
Officer In Charge
USDA, APHIS, PPQ
2001 Airport Road, Suite 308
Jackson, MS 39208

Randall Hartman
South Bay Harbor Greens
21718 Marjorie Avenue
Torrance, CA 90503

Larry E. Hawkins
USDA, APHIS, LPA
11946 Franklin
Moreno Valley, CA 92387

Charles S. Haynes
Grey Eagles, American Indian Dancers
13361 Sorrell Drive
Garden Grove, CA 92643

Mary Hegwood
Director of Communications
Foundation for Advancements-Science/Education
Park Mile Plaza, Suite 215
4801 Wilshire Boulevard
Los Angeles, CA 90010

Richard E. Hemb
Director
California Grape and Tree Fruit League
Transportation and Marketing Services
1540 E. Shaw Avenue, Suite 120
Fresno, CA 93710

W. Ritter Henn
458 Rustic Drive
Los Angeles, CA 90065

Paula Henstridge
USDA, APHIS, LPA, OD
Rm. 1147, South Building
P.O. Box 96464
Washington, DC 20090-6464

James Hester
Chief
IDCA/Agency for International Development
Latin American/Caribbean Bureau
Development Resources Office
Environmental Office Section
320 21st Street, NW., Room 2242
Washington, DC 20523

Jean Hinsley-Norcott
4818 Ocana Avenue
Lakewood, CA 90713

Delia Hitz
1325 Cabrillo, No. 12
Venice, CA 90291

Jay Holford
Ventura Company Citrus
2010 S. Steckel
Santa Paula, CA 93060

Milton Holmes
Senior Operations Officer
USDA, APHIS, PPQ, DEO
Federal Building, Room 642
6505 Belcrest Road
Hyattsville, MD 20782

Kenneth W. Holt, M.S.E.H.
U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control
Environmental Health/Injury Control (SPG F29)
1600 Clifton Road, NE.
Altanta, GA 30333

Ida Honorof
Chairperson
People Against Home Front Chemical Warfare
People for Clean Air and Pure Water
1275 Carson Woods Road
Fortuna, CA 95540

Walter E. Hopmans
1538 Alameda Padre Serra
Santa Barbara, CA 93103

Julie Horowitz
2127 North Gower Street
Hollywood, CA 90068

Earl Huff
Human Life
4453 Adam Road
Simi Valley, CA 93063

Lisabeth Hush
Founder
Law - Citizens Against Urban Spraying
12115 Magnolia Boulevard, Box 122
North Hollywood, CA 91607

Mary Hussar
762 N. Holliston Avenue
Pasadena, CA 91104

May Inscoe
Chemist
USDA, ARS, Insect Biocontrol Laboratory
Plant Sciences Institute
Rm. 108, Building 402, BARC East
Beltsville, MD 20705

Executive Director
International Regional Organization of
Plant and Animal Health Protection (OIRSA)
Ap. Po. 0161
San Salvador, El Salvador

General Manager
Irvine Company
Agriculture Division
Box 019512
Irvine, CA 92713

Fred Jackson
Tetra Tech.
630 N. Rosemead Boulevard
Pasadena, CA 91107

Patricia Jackson
5625 Graves Avenue
Encino, CA 91316

Dr. Daniel H. Janzen
Professor
University of Pennsylvania
Department of Biology
Philadelphia, PA 19104

Cheriel Jensen
13737 Quito Road
Saratoga, CA 95070

Betty Johnson
Natural Resources Chairman
League of Women Voters of Rockford
1907 Stratford Lane
Rockford, IL 61107

Paul Johnson
California Citrus Quality Council
760 East Sunkist Street
Ontario, CA 91761

George Jones
Bud. of California
Environmental Quality Control Division
Box 1759
Salinas, CA 93902

Lisa Jones
World Research Foundation
15300 Ventura Blvd., No. 405
Sherman Oaks, CA 91403

Dr. Peter Joseph
Deputy Director
USDA, APHIS, BBEP, TSS
Federal Building, Room 533
6505 Belcrest Road
Hyattsville, MD 20782

Sayed Kader
Embassy of Egypt
Agricultural Office
1350 Connecticut Avenue, NW., Suite 503
Washington, DC 20036

Dr. Sarah Kahn
Veterinary Counselor
Embassy of Australia
1601 Massachusetts Avenue, NW.
Washington, DC 20036

Victor J. Kaleta
City Attorney
City of Pasadena
100 North Garfield Avenue
Pasadena, CA 91109

Kenneth Y. Kaneshiro, Director
University of Hawaii at Manoa
Pacific Biomedical Research Center
Hawaiian Evolutionary Biology Program
3050 Maile Way, Gilmore 310
Honolulu, HI 96822

Lloyd Karch
Harbor Area Peace Commission
Box 1067
San Pedro, CA 90733

Catherine Karr
National Coalition Against the Misuse of Pesticides
701 E Street, SE., Suite 200
Washington, DC 20003

Mr. Guy W. Karr
Plant Pest Administrator
Alabama Department of Agriculture and Industries
P.O. Box 3336
Montgomery, AL 36193

Beth Kelly
719 Hillcrest Drive
Topanga, CA 90290

Mrs. Bobbye U. Kelly
7812 Kentland Avenue
West Hills, CA 91304

Keith Kelly
Director
State of Arizona, Department of Agriculture
1688 West Adams Street, Room 421
Phoenix, AZ 85007

Mary K. Kempf
Box 362
Dulzura, CA 92017

Julia Kendall
400 Canal Street, No. 329
San Rafael, CA 94901

Kenneth V. King, Jr., R. Ph.
President
Human Ecology Action League of Mississippi
97 Long Meadow Road
Brandon, MS 39042

Richard J. Kinney
Executive Vice President
Florida Citrus Packers
Box 1113
Lakeland, FL 33802

Ken Knauer, Deputy Director
USDA, FS, Northeastern Area
5 Radnor Corporate Center
P.O. Box 6775
Radnor, PA 19087-4585

Judith Knight
2621 26th Street, No. D
Santa Monica, CA 90405

L. Kopolow
Friends of the Everglades
Westward Drive
Miami Springs, FL 33166

Randy Koppang
19424 Valerio Street
Reseda, CA 91335

Gail Koretz
City of Los Angeles
City Hall, Rm. M-39
Los Angeles, CA 90012

Ken Kramer
Executive Director
Sierra Club, Lone Star Chapter
Box 1931
Austin, TX 78767

Reta K. Kuhn
801 Emerson Street, No. 3
Madison, WI 53715-1719

D. Kunz
KABC-TV
Box A
Los Angeles, CA 90027

Judy LaBue
14681 Monroe Street
Midway City, CA 92655

Thomas Latta
1061 SW. 30th Avenue
Deerfield Beach, FL 33442

Dr. Jong Song Lee
State of Texas
Air Control Board
Effects Evaluation Division
12124 Park 35 Circle
Austin, TX 78753

Lee Lester
California Farm Bureau
Santa Clara County Farm Bureau Division
2520 Lansford Avenue
San Jose, CA 95175

Gunther Leuthold
10622 Ranny Avenue
Garden Grove, CA 92643

Sandra S. Levy
Embassy of Australia
Office of Veterinary Counsellor
Division of the Minister (Commercial)
1601 Massachusetts Avenue, NW.
Washington, DC 20036-2273

J. B. and J. S. Lewis
3514 Keystone, No. 5B
Los Angeles, CA 90034

Lic. Jesus Casas de Anda
Director
Mexican Association of Citrus Packaging
Asoc. Mexicana de Empacadores de Citricos-A.C.
Constitucion 520, Box 124
Montemorelos, Nuevo Leon
Mexico

Ralph Lichty
Executive Secretary
California Citrus Quality Council
953 West Foothill Boulevard
Claremont, CA 91711

Dr. Tsu Hui Lin
Biological Scientist
USDA, APHIS, BBEP, TSS
Federal Building, Room 533
6505 Belcrest Road
Hyattsville, MD 20782

James Lindegren
Research Entomologist
USDA, ARS
Horticultural Crops Research Laboratory
2021 S. Peach Avenue
Fresno, CA 93727

Dick Lockmiller
Staley Continental, Incorporated
Box 2513
Decatur, IL 62525

Linda Lotz
Director of Programs
American Friends Service Committee
Pacific Southwest Region
980 North Fair Oaks Avenue
Pasadena, CA 91103

Dr. Carlyle A. Luer
Missouri Botanical Garden
Box 299
St. Louis, MO 63166-0299

Jane Lyons
National Audubon Society
2525 Wallingwood, Suite 1505
Austin, TX 78746

The Honorable Connie Mack
United States Senate
517 Senate Hart Office Building
Washington, DC 20510

Patricia Madigan
5051 Cahuenga Boulevard, No. 3
North Hollywood, CA 91601

Victor J. Magistrale
207 Oaklawn Avenue
South Pasadena, CA 91030
Dr. Jorge R. Mancillas
827 Levering Avenue, No. 804
Los Angeles, CA 90024

Robert Mangan
Research Entomologist
USDA, ARS
Subtropical Agricultural Research Laboratory
2301 S. International Blvd.
Weslaco, TX 78596

Howard P. Marguleas
Chairman
Sun World
Box 1028
Coachella, CA 92236-1028

Larry Mark
USDA, APHIS, PPQ
6912 Vancouver Road
Springfield, VA 22152

Jerome Marmorstein, M.D.
601 East Arrellaga, Suite 202
Santa Barbara, CA 93103

Cynthia S. Marquez
5851 NW. 38th Street
Virginia Gardens, FL 33166

Paul McClain
NCAPA
10732 Riverside
North Hollywood, CA 91602

Stephen McFadden
5237 Sarasota
Garland, TX 75043

Bobbie F. McKown
Executive Vice President
Florida Citrus Mutual
Box 89
Lakeland, FL 33802

John L. McLeod
Associate Regional Director
USDA, APHIS, PPQ
3505 Boca Chica Boulevard, Suite 360
Brownsville, TX 78520

Angela Medbery
Colorado Pesticide Network
2205 Meade Street
Denver, CO 80211

Anita Hughes Melcombe
4943 Newcastle Avenue
Encino, CA 91316

Catherine Messina
Virginia Gardens
5850 NW. 38th Street
Virginia Gardens, FL 33166

Direccion General
Gobierno de Mexico
Sec. de Agricultura y Recursos Hidraulicos
Sanidad Vegetal
Calle Guillermo Perez Valenzuela No. 127
Coyoacan 21, DF
Mexico

Karl F. Meyer
State of Arizona, Department of Agriculture
1688 West Adams
Phoenix, AZ 85007

Parm Milan
47 Sequoia Road
Fairfax, CA 94930

C. Edward Miller
Senior Entomologist
USDA, APHIS, PPD, PRAS
Federal Building, Room 811
6505 Belcrest Road
Hyattsville, MD 20782

Dr. Jacquline Miller
Allyn Museum
3621 Bayshore Road
Sarasota, FL 34234

Bill Mitchell
Breathers
334 Sunset Avenue
Venice, CA 90291

The Honorable Charles Moore
U.S. House of Representatives
Committee on Merchant Marine & Fisheries
House Annex Two, Room 575
Washington, DC 20515

Dr. Ralph Morgenweck
Assistant for Fish and Wildlife Enhancement
U.S. Department of the Interior
Fish and Wildlife Service
1849 C Street, NW.
Washington, DC 20240

Tom Morris
Navaho Superfund Office
Box 2946
Window Rock, AZ 86515

Dick Mount
Executive Vice President
Associated Produce Dealers and Brokers
746 South Central, Room 308
Los Angeles, CA 90021

Barbara A. Mullarkey
Founder
Mother Earth Network (MEN)
Box 946
Oak Park, IL 60303

Dr. John A. Mulrennan, Jr.
Chief
State of Florida Department of Health and
Rehabilitative Services, Entomology Services
Box 210
Jacksonville, FL 32231

Mary Murati
12226 Victory Boulevard, No. 197
North Hollywood, CA 91606

Lois Myers
700 E. Monroe
Austin, TX 78704

Michael J. Myers
USDA, APHIS, PPQ
89 East Sarah Lane
Tempe, AZ 85284

National Coalition Against the Misuse of Pesticides
701 East Street, SE., Suite 200
Washington, DC 20003

Joel Nelsen
President
California Citrus Mutual
Box 687
Visalia, CA 93279

Josef Nemcik
1521 12th Street
Los Angeles, CA 90019

Shashank Nilakhe
Director, Agri-Systems Programs
Texas Department of Agriculture
P.O. Box 12847
Austin, TX 78711

Ron Olsen
KTLA-TV
Hollywood, CA 90063

Noel Otten
Director
Action NOW
Division of Research and Information
1222 N. Catalina Street
Burbank, CA 91505

Marion Pack
Executive Director
Alliance for Survival
200 North Main Street, Suite M-2
Santa Ana, CA 92701

Victor S. Pankey
California Farm Bureau
1601 Exposition
Sacramento, CA 95815

Robert E. Parks
Director
California Farm Bureau
Commodity Services Division
1601 Exposition Boulevard, FB12
Sacramento, CA 95817

Joyce Paulson
505 37th Avenue, South
Moorhead, MN 56560

Linda Pendleton
11 San Sebastian
Newport Beach, CA 92660

Margo Peterman
24592 La Cienaga
Laguna Hills, CA 92653

Richard Peters
Chairman
State of California
Department of Food and Agriculture
1220 N Street, P.O. Box 942871
Sacramento, CA 94271-0001

Angela Petillo
626 Radcliffe Avenue
Pacific Palisades, CA 90272

John M. Phillips
Research Director
Nature Farming, Research and Development Foundation
6495 Santa Rosa Road
Lompoc, CA 93436

Joe Podgor
Friends of the Everglades
101 Westward Drive
Miami Springs, FL 33166

Ray Prewett
Executive Director
Texas Citrus Mutual
900 East Jackson Avenue
McAllen, TX 78501

Dennis Prichard
U.S. Department of the Interior
Fish and Wildlife Service
Santa Ana National Wildlife Refuge
Route 2, Box 202-A
Alamo, TX 78516

Dr. Alec Pridgeon
American Orchid Society
600 S. Olive Avenue
West Palm Beach, FL 33405

Keith Pritsker
City Attorney
City of Los Angeles
Office of Los Angeles City Attorney
1800 City Hall East
Los Angeles, CA 90012

Ronald Prokopy
Professor
Department of Entomology
University of Massachusetts
Amherst, MA 01003

Ray Pruitt
Manager
T.C.X.
Box 2648
McAllen, TX 78502

Mike Qualls
Attorney
City of Los Angeles
Office of Los Angeles City Attorney
1800 City Hall East
Los Angeles, CA 90012

Mr. Alfredo Ramirez
9812 Old Winery Place, Suite 10
Sacramento, CA 95827

Scott Rawlins
American Farm Bureau
225 Touhy Avenue
Park Ridge, IL 60069

Judith Redmond
Executive Director
California Action Network
Box 464
Davis, CA 95617

Rosemary Reeves
11135 Ratliffe Street
Norwalk, CA 90650

Alan Reynolds
Treasure Farms
13042 Old Myford
Irvine, CA 92720

James R. Reynolds
Regional Director
USDA, APHIS, PPQ-WR
9580 Micron Avenue, Suite I
Sacramento, CA 95827

Gladys J. Rhoads
6655 Palm, No. 99
Riverside, CA 92506

Dr. Richard Ridgway
Research Entomologist
USDA, ARS, Insect Biocontrol Laboratory
Plant Sciences Institute
Room 108, Building 402, BARC East
Beltsville, MD 20705

Ms. Connie Riherd
Assistant Director
Florida Department of Agriculture and
Consumer Services
Division of Plant Industry
P. O. Box 147100
Gainesville, FL 32614-7100

Natalie A. Roberts
USDA, APHIS, PPD
6505 Belcrest Road
Federal Building, Room 809
Hyattsville, MD 20782

Dr. John J. Robinson
Wildlife Conservation, International Division
of New York Zoology Society
Bronx, NY 10460

Peter Rockstroh
Lic.
Fundacion Interamericana de
Investigacion Tropical
APDO. Postal 2703, Guatemala

Dr. Kathleen E. Rodgers
Assistant Professor
University of Southern California School
of Medicine, Livingston Research Center
Department of Obstetrics and Gynecology
1321 North Mission Road
Los Angeles, CA 90033

Floyd E. Roe
Box 424
Paramount, CA 90723

Bill Rogers
San Bernardino Sun
399 North D Street
San Bernardino, CA 92401

Naomi Roht-Arriava
c/o Judge Browning
U.S. Courts
Court of Appeals
Box 547
San Francisco, CA 94101

Reg Rosander
USDA, APHIS, PPQ
9580 Micron Avenue, Suite I
Sacramento, CA 95827

Lorraine Rosenthal
Cancer Control Society
2043 North Berendo Street
Los Angeles, CA 90027

Maxine Rubin
521 La Mont Drive
Monterey Park, CA 91754

A. Rujas
United Press International
316 West 2nd Street
Los Angeles, CA 90012

Betsy Russell
1600 Larkin, No. 104
San Francisco, CA 94109

Alfredo A. Sadun, M.D. Ph.D.
Professor
University of Southern California School
of Medicine, Doheny Eye Institute
Depts. of Ophthalmology/Surgery (Neurological)
1355 San Pablo Street
Los Angeles, CA 90033

Dr. David Sager
Chief
State of Texas
Department of Parks and Wildlife
Environmental Contaminants Division
4200 Smith School Road
Austin, TX 78744

C. Dennis Sallis
5160 Demmy
North Hollywood, CA 91604

Ing J. Gutierrez Samperio
Director General
Gobierno de Mexico
Secretariat Agriculture/Water Resources (SARH)
Division of Plant Health
Mexico City, Mexico

Nancy Sanchez
14708 Thornlake
Norwave, CA

Richard E. Sanderson
Director
U.S. Environmental Protection Agency
Office of Federal Activities
401 M Street, SW.
Washington, DC 20460

Frances J. Sawaya
5274 Aldama Street
Los Angeles, CA 90042

Robert Schall
Staff Officer
USDA, APHIS, R&D, PDC
7340 Executive Way, Suite A
Frederick, MD 21701

D. Raymond Schmidt
5256 Wilkinson Avenue
North Hollywood, CA 91607-2411

Vangie Schock
Assistant to the City Manager
City of Alhambra, Office of the City Manager
111 South First Street
Alhambra, CA 91801

Sarah Scoville
3412 McManus Avenue
Culver City, CA 90232

Mr. James Serfis
Federal Activities Liaison
U.S. Environmental Protection Agency
Office of Federal Activities
401 M Street, SW., Mail Stop A-104
Washington, DC 20460

Dr. Joan H. Shalack
1405 Afton Street
Pasadena, CA 91103

Dr. Thomas W. Shoemaker
120 Headley Avenue
Dushore, PA 18614

Evelyn C. Sibilio
6565 Hummingbird Street
Ventura, CA 93003

Dr. Isi A. Siddiqui
Assistant Director
State of California
Department of Food and Agriculture
Division of Plant Industry
Box 942871
Sacramento, CA 94271-0001

Jerome B. Siebert
Economist
University of California
Cooperative Extension, Department of
Agricultural and Resource Economics
219 Giannini Hall
Berkeley, CA 94720

Lora Ann & Richard Sigler
Attorneys at Law
13173 Cumpston Street
Van Nuys, CA 91401-6044

Tom Silvestri
12433 Moorpark Street, Apt. 107
Studio City, CA 91604-1247

Oscar Singer
Breathers
1540 Rollins Drive
Los Angeles, CA 90063

Carol Slavin
1511 East Idahome Street
West Covina, CA 91791

Gary Smith
Officer in Charge
USDA, APHIS, PPQ
511 NW. Broadway, Room 657
Portland, OR 97209

Latimore M. Smith
Louisiana Natural Heritage Program
Louisiana Department of Wildlife and Fisheries
Box 9800
Baton Rouge, LA 70898

Susan D. Smith
3531 Buckboard Way
Lake Havasu City, AZ 86403

Ms. Katrin Snow
Xerces Society
10 SW. Ash Street
Portland, OR 97204

Gertrude Snyder
1515 El Paso Drive
Los Angeles, CA 90065

Dr. Dennis Sohocki
947 South Williams Street
Denver, CO 80209

George F. Sorn
Executive Vice President
Florida Fruit and Vegetable Association
Box 20155
Orlando, FL 32814

Mr. Robert Spaide
Operations Officer
USDA, APHIS, PPQ, PD
Federal Building, Room 816
6505 Belcrest Road
Hyattsville, MD 20782

Allen Spalt
Agricultural Resources Center
115 West Main Street
Carrboro, NC 27510

Leon Spaugy
Agricultural Commissioner
County of Los Angeles
3400 La Madera
El Monte, CA 91732

Lawrence P. Springarn
13830 Erwin Street
Van Nuys, CA 91401-2914

Mr. Larry Stanford
Assistant Director
Arizona Department of Agriculture
1688 West Adams
Phoenix, AZ 85007

Jasmine Star
Vice President
Travis Audubon Society
Box 4331
Austin, TX 78765

Director
State of California
Department of Health Services
714/744 P Street
Sacramento, CA 95814

Executive Director
State of Florida
Department of Citrus
1115 E. Memorial Boulevard
Lakeland, FL 33801-0148

Kim Steenhard
2838 Mayflower Avenue
Arcadia, CA 91006

Mike Stefan
Operations Officer
USDA, APHIS, PPQ, DEO
6505 Belcrest Road, Room 643
Hyattsville, MD 20782

Karen I. N. Stevens
Environmental Health Network
Board of Directors
44 Holly Lane
El Sobrante, CA 94803

Terry B. Stevenson
Senior Assistant City Attorney
City of Burbank
Office of the City Attorney
Box 6459
Burbank, CA 91510-6459

Rev. and Mrs. Tom Stewart
2211 West Sherwood
Stillwater, OK 74074

Dr. James Stratton
Public Health Medical Officer
California Department of Health Services
P.O. Box 942732
Sacramento, CA 94234-7320

C. A. Sue
c/o A. Peck
437 Sherman Canal
Venice, CA 90291

James Sullivan
1212 Violeta Drive
Alhambra, CA 91801

Sun World
Box 1028
Coachella, CA 92236-1028

Charles H. Svec
Executive Vice President
Miller Chemical & Fertilizer Corporation
Box 333, Radio Road
Hanover, PA 17331

Barbara Swain
Consultant in Home Economics
512 Continental Court
Pasadena, CA 91103

Veronica Taft
Environmental Health Association
5326 N. Farago Avenue
Temple City, CA 91780

John V. Taylor
Executive Vice President
California Agricultural Commissioners Assoc.
2255 South Auburn Street
Grass Valley, CA 95945

Sharon Taylor
Program Director
Environmental Health Coalition
Pesticide Use Reduction
1844 Third Avenue
San Diego, CA 92101

Wanda G. Taylor
1204 Kings Court
Gautier, MS 39553

John W. Terborgh
Professor
Duke University
Center for Tropical Conservation
3705-C Erwin Road, Wheeler Building
Durham, NC 27705

Carol Thomas
Litt, Marquez, and Fajardo
3550 Wilshire Blvd., Suite 1200
Los Angeles, CA 90010

Steven Thompson
Refuge Manager
U.S. Department of the Interior
Fish and Wildlife Service
Laguna Atascosa National Wildlife Refuge
P.O. Box 450
Rio Hondo, TX 78583

Zeada Thompson
4856 Graywood Avenue
Long Beach, CA 90808

Kathleen A. Thuner
Agricultural Commissioner
County of San Diego
Department of Agriculture, Weights, & Measures
5555 Overland Avenue, Building 3
San Diego, CA 92123-1292

The Honorable Esteban E. Torres
U.S. House of Representatives
Washington, DC 20515

Ruth Troetschler
184 Lockhart Lane
Los Altos, CA 94022

Melba L. Tucker
4604 Maxson Road
El Monte, CA 91732

Roy E. Tuckman
3661 Regal Place, No. 5
Los Angeles, CA 90068

Charles E. Uhler
1140 West Williamson Way
Fullerton, CA 92633

Manager
United Fresh Fruit and Vegetable Association
Government Relations
Box 1417 E35
Alexandria, VA 22313

Head
United Nations, Food and Agricultural Org.
International Atomic Energy Agency (IAEA)
Insect and Pest Control Section
Wagramerstrasse 5, Box 100
A-1000 Vienna, Austria

Director
United Nations, Food and Agricultural Org.
Liaison Office for North America
1001 22nd Street, NW.
Washington, DC 20437

Commander, MAC
U.S. Department of Defense
Military Airlift Command
Scott Air Force Base, IL 62225-5001

Commander
U.S. Department of Defense
Military Sealift Command
Building 210, Washington Navy Yard
Washington, DC 20398-5100

Commander
U.S. Department of Defense
Military Transportation Management Command
5611 Columbia Pike
Falls Church, VA 22041-5100

Commander in Chief
U.S. Department of Defense
U.S. Transportation Command
Scott Air Force Base, IL 62225-5001

Robert Van Steenwyk
University of California
Department of Entomological Sciences
201 Wellman Hall
Berkeley, CA 94720

Ing. Javier Vazquez Gonzalez
Director General
Gobierno de Mexico
Sec. de Agricultura y Recursos Hidraulicos
Sanidad y Proteccion Agropecuaria y Forestal
Guillermo Perez Valenzuela No.127
Coyoacan, DF 04000
Mexico

Trang Vo
Supervisory Economist
USDA, APHIS, PPD
Policy Analysis and Development
6505 Belcrest Road, Room 862
Hyattsville, MD 20782

Alice von Suskil
Chairman
City of Miami Springs
Miami Springs Ecology Board
Office of the City Clerk
201 Westward Drive
Miami Springs, FL 33166

Henry J. Voss
Director
State of California
Department of Agriculture and Food
Executive Offices, 1220 N Street, Suite 409
Sacramento, CA 94271-0001

Joel Wachs
Councilman
City of Los Angeles
City Hall, M-39
Los Angeles, CA 90012

Sheldon Wagner, M.D.
Oregon State University
Agricultural Chemistry
Agriculture and Life Science 1007
Corvallis, OR 97331-7301

Dr. David B. Wake
Museum of Vertebrate Zoology
2593 Life Sciences Building
Berkeley, CA 94720

Dawn Walker
630 South Kenmore, No. 107
Los Angeles, CA 90005

Annie Waterman
Action NOW
11018 Blix Street
North Hollywood, CA 91602

Cherie Watte
California Farm Bureau Federation
1601 Exposition Boulevard
Sacramento, CA 95815

Ken Wayne
City News
Sunset Boulevard
Hollywood, CA 90012

Sharon Webber
3132 Kerckhoff Avenue
San Pedro, CA 90731

Marjorie Weiss
401 Sycamore Road
Santa Monica, CA 90402

Rev. S. S. Weiss
1128 S. Doheny
Los Angeles, CA 99035

Michael T. Werner
Roy F. Weston, Incorporated
1 Weston Way
West Chester, PA 19380-1499

Western Growers Association
Box 2130
Newport Beach, CA 92658

Diana D. Westlund
12345 La Maida Street
North Hollywood, CA 91607

Les Whitlock
Manager
Citrus Committee
Box 2648
McAllen, TX 78502

Jack A. Wick
Regulatory Consultant
California Association of Nurserymen
1419 21st Street
Sacramento, CA 95814

Reva Willdorf
5227 Hermitage Avenue, No. 101
North Hollywood, CA 91607

Robert Williams
Box 69
Hollywood, CA 90078

Robert L. Williamson
Regional Director
USDA, APHIS, PPQ-SCR
3505 Boca Chica Blvd., Suite 360
Brownsville, TX 78521-4065

Larry J. Wilmont
4377 Colfax Avenue, No. 6
Studio City, CA 91604

Dr. Edward O. Wilson
Museum of Comparative Zoology
Harvard University
Cambridge, MA 02138

Elaine Wilson
2320 Williams View Drive
Harrisburg, PA 17112

Linda S. Wilson
350 Eventide Drive
Orange Park, FL 32073

Ellen Winer
1601 Glendon Avenue, No. 4
Los Angeles, CA 90024

David Wirth
Senior Attorney
Natural Resources Defense Council, Inc.
1350 New York Avenue, NW., Suite 300
Washington, DC 20005

Dr. Lyle Wong
Plant Industry Administrator
Hawaii Department of Agriculture
Division of Plant Industry
1428 South King Street
Honolulu, HI 96814

World Research Foundation
15300 Ventura Boulevard
Sherman Oaks, CA 91403

Gregory Wright
14161 Riverside Drive, No. 3
Sherman Oaks, CA 91423

Helene Wright
Associate Regional Director
USDA, APHIS, PPQ
9580 Micron Avenue, Suite 1
Sacramento, CA 95827

Mr. M. H. Wright
Associate Regional Director
USDA, APHIS, PPQ
Southeastern Region
3505 25th Avenue, Bldg. 1
Gulfport, MS 39501

Rufus C. Young, Jr.
Burke, Williams, and Sorensen
Attorneys at Law
611 West Sixth Street, 25th Floor
Los Angeles, CA 90017

Joy Zappe
6565 Mt. Diablo
Riverside, CA 92506

Doretta Simone Zemp
9631 Oak Pass Road
Beverly Hills, CA 90210

Claire Zweibach
3463 La Sombra
Los Angeles, CA 90068

Appendix F. References

Abe, S., and Sasaki, M., 1982. SCE as an index of mutagenesis and/or carcinogenesis. *In* Sister Chromatid Exchange, pp. 461-514. Alan R. Liss, New York.

Agrochemicals Handbook, 1990. On-line data base. Dialog Information Services, Palo Alto, CA.

Aldridge, W.N., Miles, J.W., Mount, D.L., and Verschoyle, R.D., 1979. The toxicological properties of impurities in malathion. Arch. Toxicol. 42:95-106.

Alexeeff, G.V., and Kilgore, W.W., 1983. Methyl bromide. Residue Review 88:101-153.

Anderson, J.P., 1981. Factors influencing insecticide degradation by a soil fungus, *Mucor alterans*. Dissert. Abstracts Int. 32(6):3114B-31145B, 1971.

Anger W.K., Moody, L., Burg, J., Brightwell, W.S., Taylor, B.J., Russo, J.M., Dickerson, N., Setzer, J.V., Johnson, B.L., and Hicks, K., 1986. Neurobehavioral evaluation of soil and structural fumigators using methyl bromide and sulfuryl fluoride. Neurotoxicol. 7(3):137-156.

APHIS—See U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

Bailey, R.G., 1980. Descriptions of the ecoregions of the United States. U.S. Dep. Agric. Misc. Publ. No. 1391, 77 pp.

Beat, V.B., and Morgan, D.P., 1977. Evaluation of hazards involved in treating cattle with pour-on organophosphate insecticides. Am. Vet. Med. Assoc. 170(8):812-814.

Behrens, R.H., and Dukes, C.D., 1986. Fatal methyl bromide poisoning. Brit. Ind. Med. 43:561-562.

Bollen, W.B., 1961. Interactions between insecticides and soil microorganisms. Ann Rev. Microbiol. 15:69-92.

Bond, E.J. and Svec, H.J., 1977. Control of Colorado potato beetle, *Leptinotarsa decemlineata*, in shipments of harvested potatoes. Can. Entomol. 109:285-288.

Boorman, G.A., Hong, H.L., Jameson, C.W., Yoshitomi, K., and Maronpot, R.R., 1986. Regression of methyl bromide-induced forestomach lesions in the rat. Toxicol. Appl. Pharmacol. 86:131-139.

Bowman, M.C., Leuck, D.B., Johnson, J.C., and Knox, F.E., 1970. Residues of fenthion in corn silage and effects of feeding dairy cows the treated silage. Econ. Entomol. 63(5):1523-1528.

Brady, R.F., Tobias, T., Eagles, P.F.J., Ohrner, R., Micak, J., Veale, B., and Dorney, R.S., 1979. A typology for the urban ecosystem and its relationship to larger biogeographical landscape units. Urban Ecol. 4:11-28.

Branham, B.E., and Wehner, D.J., 1985. The fate of diazinon applied to thatched turf. Agron. J. 77:101-104.

Brown, D.E., Lowe, C.H., and Pase, C.P., 1977. Biotic communities of the Southwest. U.S. Dep. of Agric., General Technical Rep. RM-41, 342 pp.

Burkhard, N., and Guth, J.A., 1979. Photolysis of organophosphorus insecticides on soil surfaces. Pest. Sci. 10:313-319.

Burkhard, N., and Guth, J.A., 1981. Rate of volatilization of pesticides from soil surfaces: Comparison of calculated results with those determined in a laboratory model system. Pesti. Sci. 12:37-44.

Calabrese, E.J., 1984. Ecogenetics. John Wiley and Sons, New York.

California Department of Food and Agriculture (CDFA), 1991. Environmental monitoring of malathion aerial applications used to eradicate Mediterranean fruit flies in Southern California, 1990. Environmental Hazards Assessment Program, Sacramento, CA.

California Department of Fish and Game (CDFG), 1982. Impact on Fish and Wildlife from Broadscale Aerial Malathion Applications in South San Francisco Bay Region, 1981. Environmental Services Branch. Administrative Report 82-2. B.J. Finlayson, G. Faggella, H. Jong, E. Littrell, and T. Lew. Pesticide Investigations Unit, Water Pollution Control Laboratory.

California Department of Health Services (CDHS), 1991. Health risk assessment of aerial application of malathion-bait. CDHS, Sacramento, CA.

CDFA—See California Department of Food and Agriculture

CDFG—See California Department of Fish and Game

CEQ—See Council on Environmental Quality.

Clark, J.R., Borthwick, P.W., Goodman, L.R., Patrick, Jr., J.M., Lores, E.M., and Moore, J.C., 1987a. Comparison of laboratory toxicity test results with responses of estuarine animals exposed to fenthion in the field. Environ. Toxicol. Chem. 6:151-160.

Cohen, S.D., and Ehrich, M., 1976. Cholinesterase and carboxylesterase inhibition by dichlorvos and interactions with malathion and triorthotolyl phosphate. Toxicol. Appl. Pharmacol. 37:39-48.

Cohen, S.D., and Murphy, S.D., 1970. Comparative potentiation of malathion by triorthotolyl phosphate in four classes of vertebrates. Toxicol. Appl. Pharmacol. 16:701-708.

Council on Environmental Quality, 1972. Integrated pest management. November 1972.

Danse, L.H.J.C., Van Velsen, F.L., and van der Heijden, C.A., 1984. Methyl bromide: carcinogenic effects in the rat forestomach. Toxicol. Appl. Pharmacol. 72:262-271.

Davies, D.B., and Holub, B.J., 1980. Toxicological evaluation of dietary diazinon in the rat. Arch. Environ. Contam. Toxicol. 9:637-650.

Desi, I., Varga, L., and Farkas, I., 1978. Studies on the immunosuppressive effect of organochlorine and organophosphoric pesticides in subacute experiments. Hyg. Epidemiol. Microbiol. Immunol. 22(1):115-122.

Ehler, L.W., and Endicott, P.C., 1984. Effect of malathion-bait sprays on biological control of insect pests of olive, citrus, and walnut; Hilgardia 52:5, 1-47.

El-Refai, A., and Hopkins, T.L., 1972. Malathion adsorption, translocation and conversion to malaoxon in bean plants. Assoc. Off. Anal. Chemists J. 55(3):526-531.

EPA—See U.S. Environmental Protection Agency.

EPA, ECAO—See U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office.

EPA, ODW—See U.S. Environmental Protection Agency, Office of Drinking Water.

EPA, OHEA—See U.S. Environmental Protection Agency, Office of Health and Environmental Assessment.

EPA, OPP—See U.S. Environmental Protection Agency, Office of Pesticide Programs.

EPA, OPTS—See U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances.

EPA, ORD—See U.S. Environmental Protection Agency, Office of Research and Development.

Eskafi, F.M., 1988. Infestation of citrus by *Anestrepha* spp. and *Ceratitis capitata* (Diptera:Tephritidae) in high coastal plains of Guatemala. Environ. Entomol. 17:52.

Farm Chemicals Handbook, 1991. Pesticide dictionary. p. C 237 Meister Publishing Company, Willoughby, OH.

Felsot, A., and Dahm, P.A., 1979. Sorption of organophosphorus and carbamate insecticides by soil. J. Agric. Food Chem. 27:557-563.

Fujie, K., Aoki, T., and Wada, M., 1990. Acute and subacute cytogenic effects of the trihalomethanes on rat bone marrow cells *in vivo*. Mutat. Res. 242:111-119.

Fukuto, T.R., 1983. Toxicological properties of trialkyl phosphorothioate and dialkyl, alkyl- and arylphosphorothioate esters. Environ. Sci. Health Part B 18:89-117.

Gaines, T.B., 1960. The acute toxicity of pesticides to rats. Toxicol. Appl. Pharmacol. 2:88-99.

Garretson, A.L., and San Clemente, C.L., 1968. Inhibition of nitrifying chemolithotropic bacteria by several insecticides. J. Econ. Entomol. 61(1):285-288.

Gary, N.E., and Mussen, E.C., 1984. Impact of Mediterranean Fruit Fly Malathion Bait Spray on Honey Bees. Environ. Entomol. 13:711-717.

Garry, V.F., Nelson, R.L., Griffith, J., and Harkins, M., 1990. Preparation for human study of peticide applicators: Sister chromatid exchanges and chromosomal aberrations in cultured human lymphocytes exposed to selected fumigants. Teratog. Carcinog. Mutagen. 10:21-29.

Gay, H.H., 1962. Blood and urinary levels following exposure to bromides. Indian Med. Surg. 31:438-439.

Getzin, L.W., 1967. Metabolism of diazinon and zinophos in soils. J. Econ. Entomol. 60(2):505-508.

Getzin, L.W., 1968. Persistence of diazinon and zinophos in soil: Effects of autoclaving, temperature, moisture, and acidity. J. Econ. Entomol. 61(6):1560-1565.

Getzin, L.W., and Rosefield, I., 1966. Persistence of diazinon and zinophos in soil. J. Econ. Entomol. 50(3):512-516.

Giles, R.H., Jr., 1970. The ecology of a small forested watershed treated with the insecticide malathion--S^{25}. Wildlife Monographs No. 24.

Gosselin, R.E., Smith, R.P., and Hodge, H.C., 1984. Clinical toxicology of commercial products, 5th ed. Williams and Wilkins, Baltimore, MD.

Greany, P.D., Styer, S.L., Davis, P.L., Shaw, P.E., and Chambers, D.L., 1983. Biochemical resistance of citrus to fruit flies - demonstration and elucidation of resistance to the Caribbean fruit fly *Anastrepha suspensa*. Entomol. Exp. Appl. 34:40.

Great Lakes Chemical Corporation, 1989. Material safety data sheet, Meth-O-Gas, Meth-O-Gas 100. Great Lakes Chemical Corporation.

Griffin, III, D.E., and Hill, W.E., 1978. In-vitro breakage of plasmid DNA by mutagens and pesticides. Mutat. Res. 52:161-169.

Hardin, B.D., Bond, G.P., Sikov, M.R., Andrew, F.D., Beliles, R.P., and Niemeier, R.W., 1981. Testing of selected workplace chemicals for teratogenic potential. Scand. Work Environ & Health. 7 Suppl. 4:66-75.

Hayes, W.J., Jr., and Laws, E.R., Jr., eds., 1991. Handb. Pestic. Toxicol. Academic Press, New York. 3 vols., 1576 pp.

Hazardous Substances Data Base (HSDB), 1991. On-line data base. National Library of Medicine, Bethesda, MD.

Honma, T., Miyagawa, M., Sato, M., and Hasegawa, H., 1985. Neurotoxicity and metabolism of methyl bromide in rats. Toxicol. Appl. Pharmacol. 81:183-191.

Horvath, L., 1982. Persistence of organophosphorus pesticides in aquatic environments. Coordinated programme on isotope-tracer-aided research and monitoring on agricultural residue-biological interactions in aquatic environment. Final report for the period 1 July 1976 to 31 July 1982. International Atomic Energy Agency, Vienna, Austria.

Howard, P.H., (ed.), 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Vol. III Pesticides. Lewis Publishers, MI.

Hurtt, M.E., and Working, P.K., 1988. Evaluation of spermatogenesis and sperm quality in the rat following acute inhalation exposure to methyl bromide. Fundam. Appl. Toxicol. 10:490-498.

Ichinohe, F., Hashimoto, T., and Nakasone, S., 1977. Faunal survey of insects and spiders killed by protein hydrolysate insecticide bait for control of melon fly. Res. Bull. Pl. Prot. Japan. 14:64-70.

Jenkins, D., Klein, S.A., Yang, M.S., Wagenet, R.J., and Biggar, J.W., 1978. The accumulation, translocation, and degradation of biocides at land disposal sites: the fate of malathion, carbaryl, diazinon, 2,4-D butoxyethyl ester. Water Res. 12:713-723.

Johansen, C.A., 1977. Pesticides and pollinators. Annu. Rev. Entomol. 22:177-192.

Keplinger, M.L., and Deichmann, W.B., 1967. Acute toxicology of combinations of pesticides. Toxicol. Appl. Pharmacol. 10:586-595.

Klaassen, C.D., Amdur, M.O., and Doull, J., 1986. Cassarett and Doull's toxicol., the basic science of poisons, 3rd ed. MacMillan Publishing Co., Inc., New York.

Klisenko, M.A., and Pis'mennaya, M.V., 1979. Photochemical conversion of organophosphorus pesticides in the air. Gig. Tr. Prof. Zabol. 6:56-58.

Knaak, J.B., and O'Brien, R.D., 1960. Insecticide potentiation: Effect of EPN on *in vivo* metabolism of malathion by the rat and dog. Agric. Food Chem. 8:198-203.

Kuchler, A.W., 1964. Potential natural vegetation of the conterminous United States. Am. Geogr. Soc. Spec. Publ. 36., 116 pp.

Labat-Anderson Incorporated, 1992a. Fruit fly program chemical background statement: chlorpyrifos. Labat-Anderson Incorporated, Arlington, VA.

LaFleur, K.S., 1979. Sorption of pesticides by model soils and agronomic soils: Rates and equlibria. Soil Sci. 127(2):94-101.

Lavy, T.L., Norris, L.A., Mattice, J.D., and Marx, P.B., 1987. Exposure of forestry ground workers to 2,4-D picloram and dichorprop. Environ. Toxicol. Chem. 6:209-224.

Lichtenstein, E.P., Fuhremann, T.W., Scopes, N.E.A., and Skrentny, R.F., 1967. Translocation of insecticides from soils into pea plant, effects of the detergent LAS on translocation and plant growth. J. Agric. Food Chem. 15(1):266-272.

Lopez, D., Alexander, C., Merchan, M., and Carrascal, E., 1986. *In vitro* induction of alterations in peripheral blood lymphocytes by different doses of diazinon. Bull. Environ. Contam. Toxicol. 37:517-522.

Marking, L.L., and Dawson, V.K., 1975. Method for assessment of toxicity or efficacy of mixtures of chemicals, U.S. Fish Wildl. Serv., Investigations in Fish Control, Rep. No. 67., 8 pp.

Matsumara, F., 1985. Toxicology of insecticides, p.77-78, 224-229. Plemnum Press, NY.

McBride, J.R. and Reid, C., 1988. *In* A guide to wildlife habitats of California. Pacific Southwest Forest and Range Experimental Station, California Fish and Game, Pacific Gas and Electric, and USDA Forest Service Region 5, p. 142-143.

McElroy, M.B., Salawitch, R.J., Wofsy, S.C., 1986. Antarctic O_3: Chemical mechanisms for the spring decrease. Geophys. Res. Lett. 13(12):1296-1299.

Meier, E.P., Dennis, W.H., Rosencrance, A.B., Randall, W.F., Cooper, W.J., and Warner, M.C., 1979. Sulfotepp, a toxic impurity in formulations of diazinon. Bull. Environ. Contam. Toxicol. 23(1-2):158-164.

Melland, R., 1992. Memorandum regarding biological control philosophy, dated August 7, 1992. U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

Miles, J.R.W., Tu, C.M., and Harris, C.R., 1979. Persistence of eight organophosphorus insecticides in sterile and nonsterile mineral and organic soils. Bull. Environ. Contam. Toxicol. 22:312-318.

Mix, J., 1992. Methyl bromine producers take firm position. Pest Control April:42-43.

Moeller, H.C., and Rider, J.A., 1962. Plasma and red blood cell cholinesterase activity as indications of the incipient toxicity of ethyl-p-nitrophenyl thiobenzenephosphonate (EPN) and malathion in human beings. Toxicol. Appl. Pharmacol. 4:123-130.

Moore, G.A., and Cline, K., 1989. Genetic transformation for the production of new citrus varieties. Citrus & Veg. Mag. 52(10):14-15.

Nash, R.G., Kearney, P.C., Maitlen, J.C., Sell, C.R., and Fertig, S.N., 1982. Agricultural applicators exposure to 2,4-dichlorophenoxyacetic acid. *In* Pesticide residues and exposures. Am. Chem. Soc. Symp. Ser. No. 238, p. 119-132.

National Academy of Sciences, 1977. Drinking Water and Health, Vol. 1. National Academy of Sciences, Washington, DC.

National Cancer Institute, 1979. Bioassay of diazinon for possible carcinogenicity. Tech. Report Series No. 137. U.S. Dep. Health, Educ., Welfare, Natl. Cancer Inst., Bethesda, MD.

National Institute for Occupational Safety and Health, Occupational Safety and Health Administration, 1978. Occupational health guideline for malathion. U.S. Dep. of Health Hum. Serv./U.S. Dep. Labor, Washington, DC.

National Research Council (NRC), 1980. Principles of toxicological interactions associated with multiple chemical exposures. National Academy Press, Washington, DC.

National Research Council, 1983. Risk assessment in the Federal government: managing the process. National Academy Press, Washington, DC.

National Research Council, 1989. Alternative agriculture. National Academy Press, Washington, DC. p. 208-209.

Neary, D.G., 1985. Fate of pesticides in Florida's forests: An overview of potential impacts on water quality. Proc. Soil Crop Sci. Soc. Fla. 44:18-24.

Nigg, H.N., Reinert, J.A., Stamper, J.H., and Fitzpatrick, G.E., 1981. Disappearance of acephate, methiamidophos, and malathion from citrus foliage. Bull. Environm. Contam. Toxicol. 26:267-272.

NRC—See National Research Council.

Obersteiner, E.J., and Sharma, R.P., 1976. Cytotoxicity of selected organophosphates in chick ganglia cell cultures. Fed. Proc. 35:504.

Omernick, J.M., 1986. Ecoregions of the conterminous United States. Map. U.S. Environ. Prot. Agency, Corvallis Research Laboratory.

Paris, D.R., and Lewis, D.L., 1973. Chemical and microbial degradation of ten selected pesticides in aquatic systems. Residue Rev. 45:95-124.

Pascal, D.C., and Neville, M.E., 1976. Chemical and microbial degradation of malaoxon in an Illinois soil. Environ. Qual. 5(4):441-443.

Pfadt, R.E., (ed.), 1971. Fundamentals of applied entomology, 2nd edition. The Macmillan Co., New York.

Pike, K.S., and Getzin, L.W., 1981. Persistence and movement of chlorpyrifos in sprinkler-irrigated soil. J. Econom. Entomol. 74(4):385-388.

Prather, M.J., McElroy, M.B., & Wofsy, S.C., 1984. Reductions in ozone at high concentrations of stratospheric halogens. Nature 312(5991):227-231

Rodgers, K.E., Leung, N., Imamura, T., and Devens, B.H., 1986. Rapid *in vitro* screening assay for immunotoxic effects of organophosphorus and carbamate insecticides on the generation of cytotoxic t-lymphocyte responses. Pestic. Biochem. Physiol. 26:292-301.

Ryan, D.L., and Fukuto, T.R., 1985. The effect of impurities on the toxicokinetics of malathion in rats. Pestic. Biochem. Physiol. 23:413-424.

Sax, N.I., and Lewis, R.J., 1989. Dangerous properties of industrial materials, 7th ed., pp. 544-546. Van Nostrand Reinhold, New York.

Sayers, R.R., Yant, W.P., Thomas, B.G.H., and Berger, L.B., 1929. Physiological response attending exposure to vapors of methyl bromide, methyl chloride, ethyl bromide and ethyl chloride. Publ. Health Bull. 185(1-8):20-40.

Segawa, R.T., Sitts, J.A., White, J.H., Marade, S.J., and Powell, S.J., 1991. Environmental monitoring-of malathion aerial applications used to eradicate Mediterranean fruit flies in southern California. Calif. Dep. Food Agric., Environmental Hazards Assessment Program.

Seume, F.W., and O'Brien, R.D., 1960. Potentiation of the toxicity to insects and mice of phosphorothioates containing carboxyester and carboxyamide groups. Toxicol. Appl. Pharmacol. 2:495-502.

Simmons, V.F., Poole, D.C., Riccio, D.E., Mitchell, A.D., and Waters, M.D., 1979. Environ. Mutagen. 1:142-143.

Singh, S.P., Sharma, L.D., Bahga, H.S., and Garg, S.K., 1988. A note on the effect of fenthion feeding on the immunological response of chickens. Indian Vet. Med. 8(2):174-175.

Smith, G.J., 1987. Pesticide use and toxicology in relation to wildlife: organophosphate and carbamate compounds. Resource Publ. 170. 171 pp. U.S. Dep. Inter., Fish Wildl. Serv. Washington, DC.

Smith, G.N., Watson, B.S., and Fischer, F.S., 1967. Investigations on Dursban® insecticide: Uptake and translocation of [^{36}Cl] O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphorothioate and [^{14}C] O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphorothioate by beans and corn. J. Agric. Food Chem. 15:127-131.

Soliman, S.A., Sovocool, G.W., and Curley, A., 1982. Two acute human poisoning cases resulting from exposure to diazinon transformation products in Egypt. Arch. Environ. Health 37(4):207-212.

Spyker, J.M., and Avery, D.L., 1977. Neurobehavioral effects of prenatal exposure to the organophosphate diazinon in mice. Toxicol. Environ. Health 3:989-1002.

Sturges, W.T., and Harrrison, R.M., 1986. Bromine in marine aerosols and the origin, nature and quantity of natural atmospheric bromine. Atmospheric Environ. 20(3):1485-1496.

Sumner, D.D., Keller, A.E., Honeycutt, R.C., and Guth, J.A., 1987. Fate of diazinon in the environment. In Fate of pesticides in the environment. Pub. 3320, Ag. Exp. Sta., Div. Agric. Nat. Res., University of California, Davis, CA.

Thomas, P.T., and House, R.V., 1989. Pesticide-induced modulation of the immune system. *In* Ragsdale, N.N., and Menzer, R.E., eds. Carcinogenicity and pesticides: Principles, issues, and relationships. Symposium at the 196th meeting of the American Chemical Society, Los Angeles, CA. Am. Chemi. Soc., Washington, DC.

Toia, R.F., March, R.B., Umetsu, N., Mallipudi, N.M., Allahyari, R., and Fukuto, T.R., 1980. Identification and toxicological evaluation of impurities in technical malathion and fenthion. Agric. Food Chem. 28:599-604.

Troetscheler, R.G., 1983. Effects of nontarget arthropods of malathion bait sprays used in California to eradicate the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Dystera:Tephritidae). Environ. Entomol. 12: 1816-1822.

Tucker, J.D., Zu, J., Stewart, J., and Ong, T., 1985. Development of a method to detect volatile genotoxins using sister chromatid exchanges. EMS Abst. (no volume number):48.

Urban, D.J. and Cook, N.J., 1986. Ecological risk assessment. U.S. Environ. Prot. Agency, Hazard Evaluation Division.

USDA—See U.S. Department of Agriculture.

USDA, APHIS—See U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

USDA, SCS—See U.S. Department of Agriculture, Soil Conservation Service.

U.S. Bureau of the Census, 1991. Statistical abstract of the United States: 1991 (111^{th} Edition). Washington, DC. 418 pp.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine Treatment Manual.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, 1989. Action plan Mediterranean fruit fly *Ceratitis capitata* (Wiedemann), Hyattsville, MD.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 1992a. Human health risk assessment for fruit fly eradication programs. Hyattsville, MD.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 1992b. Nontarget Species Risk Assessment for the Medfly Cooperative Eradication Program. Hyattsville, MD.

U.S. DHHS, NIOSH, OSHA—See U.S. Department of Health and Human Services

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, Occupational Safety and Health Administration, 1978. Occupational health guideline for malathion. U.S. Dep. of Health Hum. Serv./U.S. Dep. Labor, Washington, DC.

U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office, 1992. Integrated risk assessment system. Chemical file for methyl bromide. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH.

U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office, 1984. Health and environmental effects profile for diazinon. Cincinnati, OH.

U.S. Environmental Protection Agency, Office of Drinking Water, 1988. Diazinon. Health advisory. Washington, DC.

U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, 1990. Exposure Factors Handbook. Office of Research and Development, Washington, DC. EPA/600/8-89/043.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1984. Guidance for the reregistration of pesticide products containing chlorpyrifos as the active ingredient. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1984a. Chlorpyrifos Science Chapters. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1985. Toxicity one-liner no. 456F: Fenthion. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1988a. Diazinon Toxchem No. 342, Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1988b. Guidance for the reregistration of pesticide products containing fenthion as the active ingredient. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1988c. Pesticide fact sheet No. 169. Fenthion. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1989b. Toxchem No. 535. Malathion. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1989c. Tox one-liner No. 219AA. Chlorpyrifos.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1989d. Registration standard for the reregestration of pesticide products containing chlorpyrifos as the active ingredient. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1990. RfD tracking report. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1990a. Toxchem no. 555. Methyl bromide. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticide Programs, 1992. Environmental Fate One Liner Data Base. Version 3.04. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, 1988a. Diazinon science chapters. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, 1988b. Guidance for the reregistration of pesticide products containing fenthion as the active ingedient. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, 1988a. Guidance for reregistration of pesticide products containing malathion as the active ingredient. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, 1989. Guidance for the reregistration of pesticide products containing diazinon as the active ingredient. Office of Pesticide Programs, Washington, DC. 540/RS-89-016.

U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, 1990. EPA memorandum. Peer review of malathion. Washington, DC.

U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, 1990a. RfD tracking report. Washington, DC.

U.S. Environmental Protection Agency, Office of Research and Development, 1986. Health and environmental effects profile for methyl bromide. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Environmental Protection Agency. EPA/600/X-86/171.

U.S. Environmental Protection Agency, Office of Research and Development, 1988. Integrated risk information system (IRIS). Cincinnati, OH.

Van Wambeke, E., Vanachter, A., Pauwels, J., and Van Assche, C., 1982. Mixtures of methyl bromide and methyl chloride and their effects on gas diffusion in soil, effectivity and bromide residues. Med. Fac. Landbouww. Rijksuniv. Gent. 47/1:339-345.

Verberk, M.M., Rooyakkers-Beemster, T., de Vlieger, M., and van Vliet, A.G.M., 1979. Bromine in blood, EEG, and transaminases in methyl bromide workers. Brit. Ind. Med. 36:59-62.

Walker, W.W., Cripe, D.R., Prichard, P.H., and Bourquin, A.W., 1988. Biological and abiotic degradation of xenobiotic compounds in *in vitro* estuarine water and sediment/water systems. Chemosphere 17(12):2255-2270.

Walker, W.W., and Stojanovic, B.J., 1973. Microbial versus chemical degradation of malathion in soil. J. Environ. Qual. 2(2):229-232.

Washburn, J.A., Tassan, R.L., Grace, K., Bellis, E., Hagen, K.S., and Frankie, G.W., 1983. Effect of malathion sprays on the ice plant insect system; California Agriculture. January-February, p. 30-32.

Wegman, R.C.C., Greve, P.A., DeHeer, H., Hamaker, P.H., 1981. Methyl bromide and bromide-ion in drainage water after leaching of glasshouse soils. Water, Air, and Soil Pollution 16:3-11.

Weir, R.J., Jr., and Fisher, R.S., 1972. Toxicologic studies on borax and boric acid. Toxicol. Appl. Pharmacol. 23:351-364.

White, D.H., Mitchell, C.A., Wynn, L.D., Flickinger, E.L., and Kolbe, E.J., 1982. Organophosphate insecticide poisoning of Canada geese in the Texas panhandle. Field Ornithol. 53:22-27.

WHO—See World Health Organization.

Williams, M.W., Fuyat, H.N., and Fitzhugh, O.C., 1959. The subacute toxicity of four organic pesticides to dogs. Toxicology 1:1-7.

Wofsy, S.C., McElroy, M.B., and Yung, Y.L., 1975. The chemistry of atmospheric bromine. Geophys. Res. Lett. 2(6):215-218.

Wolfe, H.R., Armstrong, J.F., and Durham, W.F., 1974. Exposure of mosquito control workers to fenthion. Mosq. News 34(3):263-267.

Wolfe, N.L., Zepp, R.G., Gordon, H.A., Baughman, G.L., and Cline, D.M., 1977. The chemistry of atmospheric bromine. Geophysical Res. Letters. 2(6)215-217.

World Health Organization, 1989. Dichlorvos. World Health Organization Distribution and Sales Service, Geneva, Switzerland. 157 pp.

World Health Organization of the United Nations, International Agency for Research on Cancer, 1983. IARC Monographs on the carcinogenic risk of chemicals to humans - miscellaneous pesticides (vol. 30). International Agency for Research on Cancer, Geneva, Switzerland.

Wright, A.S., Hutson, D.H., and Wooder, M.F., 1979. The chemical and biochemical reactivity of dichlorvos. Arch. Toxicol. 42:1-18.

References used but not cited (for tables IV-1 through IV-12):

Adams, E.D., 1974. Soil survey of eastern Maricopia and northern Pinal Counties area, Arizona. USDA, SCS; Arizona Agricultural Experiment Station. 61 pp.

Anonymous, 1963. General soil maps, Baldwin County, Alabama. USDA, SCS; Alabama Agricultural Experiment Station; Alabama Department of Agriculture and Industries.

Anonymous, 1969. General soil map of Plaquemines Parish, Louisiana. USDA, SCS; Louisiana Agricultural Experiment Station.

Anonymous, 1981. Land resource regions and major land resource areas of the United States. USDA, SCS. Agriculture Handbook 296. 156 pp.

Anonymous, 1990. Soil survey tables of Baldwin County, Alabama. USDA, SCS; Alabama Agricultural Experiment Station; Alabama Department of Agriculture and Industries.

Anonymous, 19??. Soil survey of Palm Beach County area, Florida. USDA, SCS; Univ. of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Station & Soil Science Department.

Arizona Agricultural Statistics Service, 1991. 1990 Arizona Agricultural Statistics. Arizona Agricultural Statistics Service, Bull. S-26.

Arroues, K.D., and Anderson, C.H., 1986. Soil survey of Kings County, California. USDA, SCS; University of California Agricultural Experiment Station. 212 pp.

Bailey, R.G., 1980. Descriptions of the ecoregions of the United States. U.S. Department of Agriculture, Misc. Publ. No. 1391. 77 pp.

Barbour, M.G., and Billings, W.D., 1988. North American vegetation, Cambridge University Press, 434 pp.

Barmore, R.L., 1980. Soil survey of Yuma-Wellington area, parts of Yuma County, Arizona and Imperial County, California. USDA, SCS; Arizona Agricultural Experiment Station; California Agricultural Experiment Station. 104 pp.

Bowman, R.H., Bishop, R.E., and Griffin, R.W., 1973. Soil survey of San Diego County (excluding Anza-Borrego and Cuyamaca State Parks), California, part II. USDA, SCS & FS; University of California Agricultural Experiment Station; USDI, Bureau of Indian Affairs; Department of the Navy, U.S. Marine Corps; HUD; and the County of San Diego Planning Division. 118 pp.

Bowman, R.H., and Estrada, D.C., 1980. Soil survey of Santa Cruz County, California. USDA, SCS; University of California Agricultural Experiment Station. 148 pp.

Bowman, R.H., House, A.A., Kester, G., Estrada, D.D., and Wachtell, J.K., 1973. Soil survey of San Diego County (excluding Anza-Borrego and Cuyamaca State Parks, California, part I. USDA, SCS & FS; University of California Agricultural Experiment Station; USDI, Bureau of Indian Affairs; Department of the Navy, U.S. Marine Corps; HUD; and the County of San Diego Planning Division. 104 pp.

Brady, R.F., Tobias, T., Eagles, P.F.J., Ohrner, R., Micak, J., Veale, B., and Dorney, R.S., 1979. A typology for the urban ecosystem and its relationship to larger biogeographical landscape units. Urban Ecol. 4:11-28.

Brown, D.E. (ed.), 1982. Biotic communities of the American Southwest-United States and Mexico. Desert Plants (Special Issue) 4(1-4):1-342.

Brown, D.E., C.H. Lowe, and Pase, C.P., 1977. Biotic communities of the Southwest. U.S. Dep. Agric., Gen. Tech. Rep. RM-41. 342 pp.

Calabrese, E.J., 1978. Pollutants and high-risk groups. The biological basis of increased human susceptibility to environmental and occupational pollutants. John Wiley and Sons, New York, NY.

California Department of Finance, 1991. California Statistical Abstract. California Department of Finance, Financial and Economic Research Unit. 206 pp.

California Fish and Game Department, 1982. Impact on fish and wildlife from broadscale aerial malathion applications in south San Francisco Bay region, 1981. Environ. Serv. Branch Administrative Rep. 82-2.

Camp, P.D., 1986. Soil survey of Aguila-Carefree area, parts of Maricopa and Pinal Counties, Arizona. USDA, SCS; USDI, BIA & BLM; Arizona Agricultural Experiment Station. 306 pp.

Conner, W.H. and Day, Jr., J.W., (eds.), 1987. The ecology of Barataria Basin, Louisiana: an estuarine profile. U.S. Fish Wildl. Serv. Biol. Rep. 85 (7.13). 165 pp.

Cooperrider, A.Y., Boyd, R.J., and Stuart, H.R., (eds.), 1986. Inventory and monitoring of wildlife habitat. U.S. Dep. Inter., Bur. Land Mange. Serv. Center. Denver, CO. 858 pp.

CRR, 1991. Chemical Regulation Reporter. November 8, 1991, 15:1127.

Dolittle, J.A., and Schellentrager, G., 1989. Soil survey of Orange County, Florida. USDA, SCS; Univ. of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Station & Soil Science Department; Florida Department of Agriculture and Consumer Services. 152 pp.

Edwards, R.J., and Contreras-Balderas, S. In press in 1988. Historical changes in the ichthyofauna of the Lower Rio Grande (Rio Bravo del Norte), Texas and Mexico. Proceedings of the Tamaulipan Biotic Province Symposium. Tex. Parks. Will. Dep., Austin, TX.

Emlen, J.T., 1974. An urban bird community in Tucson, Arizona: derivation, structure, regulation. Condor 76:184-197.

Ernstrom, D.J., 1984. Soil survey of San Luis Obispo County, California, coastal part. USDA, SCS; University of California Agricultural Experiment Station. 265 pp.

Evens, J.G., Page, G.W., Laymon, S.A., and Stallcup, R.W., 1991. Distribution, relative abundance, and status of California black rail in western North America. Condor 93:952-966

Finlayson, B.J., Faggella, G., Jong, H., Littrell, E., and Lew, T., 1982. Impact on fish and wildlife from broadscale aerial malathion applications in south San Francisco Bay region, 1981. California State Resources Agency, Department of Fish and Game, Environmental Services Branch, Administrative Report 82-2.

Griffin, J.R., 1988. Oak woodland, p. 383-415. *In* M.G. Barbour and J. Major (eds.), Terrestrial vegetation of California, California native plant society, Special Publ. No. 9. 1020 pp.

Hartman, G.W., 1973. General soil map with interpretations for land use planning, Maricopa County, Arizona. USDA, SCS; The Natural Resource Conservation Districts in Maricopa County. 49 pp.

Hartman, G.W., 1977. Soil survey of Maricopa County, Arizona, central part. USDA, SCS; Arizona Agricultural Experiment Station. 117 pp.

Heady, H.F., 1988. Valley grassland, pp. 491-514. *In* M.G. Barbour and J. Major (eds.), Terrestrial vegetation of California, California native plant society, Special Publ. No. 9. 1020 pp.

Hickman, G.L., and Owens, C., 1980. Soil survey of Mobile County, Alabama. USDA, SCS; Alabama Agricultural Experiment Station, Alabama Department of Agricultural and Industries. 134 pp.

Holland, R., and Jain, S., 1988. Vernal pools, pp. 515-533. *In* M.G. Barbour and J. Major (eds.), Terrestrial vegetation of California, California native plant society, Special Publ. No. 9. 1020 pp.

Holland, R.F., 1986. Preliminary descriptions of the terrestrial natural communities of California. State of California, The Resources Agency, Department of Fish and Game. 156 pp.

Huntington, G.L., 1971. Soil survey of Eastern Fresno County, California. USDA, SCS; University of California Agricultural Experiment Station. 323 pp.

Jacobs, J.L., 1981. Soil survey of Hidalgo County, Texas. USDA, Soil Conservation Service, in cooperation with the Texas Agricultural Experiment Station. 171 pp.

Jahrsdoerfer, S.E., and Leslie, Jr., D.M., 1988. Tamaulipan brushland of the lower Rio Grande Valley of South Texas: description, human impacts, and management options. U.S. Fish Wildl. Serv., Biol. Rep. 88(36). 63 pp.

Jakle, M.D., and Gatz, T.A., 1985. Herpetofaunal use of four habitats of the middle Gila River drainage, Arizona. U.S. Forest Service Gen. Tech. Rep. Rm No. 120. pp. 355-358

Knecht, A.A., 1980. Soil survey of Riverside County, California, Coachella Valley area. USDA, SCS; University of California Agricultural Experiment Station. 89 pp.

Leifer, L., and Rabey, D.F., 1980. Soil survey of Los Angeles County, California, West San Fernando Valley area. USDA, SCS; West Los Angeles County Resource Conservation District; University of California Agricultural Experiment Station. 107 pp.

Lindsey, W.C., 1974. Soil survey of Santa Clara County, California, Santa Clara area. USDA, SCS; University of California Agricultural Experiment Station. 90 pp.

Lindsey, W.C., 1983. Soil survey of San Luis Obispo County, California, Paso Robles area. USDA, SCS; University of California Agricultural Experiment Station. 236 pp.

Lowe, C.H., (ed.), 1978. The vertebrates of Arizona, with major sections on Arizona habitats. The University of Arizona Press. Tucson.

MacDonald, K.B., 1988. Coastal salt marsh, pp. 263-294. *In* M.G. Barbour and J. Major (eds.), Terrestrial vegetation of California, California native plant society, Special Publ. No. 9. 1020 pp.

Matthews, D., 1983. Soil survey of Jefferson Parish, Louisiana. USDA, SCS; Louisiana Agricultural Experiment Station; Louisiana State Soil and Water Conservation Committee. 95 pp.

Matthews, S.D., 1984. Soil survey of Lafourche Parish, Louisiana. USDA, SCS; Louisiana Agricultural Experiment Station; Louisiana State Soil and Water Conservation Committee. 106 pp.

Mayer, K.E., and Laudenslayer, Jr., W.F., (eds.), 1988. A guide to wildlife habitats of California. Calif. Dept. of Forestry and Fire Protection. 166 pp.

McBride, J.R., and Reid, C., 1988. *In* A guide to wildlife habitats of California. USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station, California Fish and Game, Pacific Gas and Electric, and USDA Forest Service, Region 5.

Miller, E.N., 1971. Soil survey of Charleston County, South Carolina. USDA, SCS and FS; South Carolina Agricultural Experiment Station. 77 pp.

Minckley, W.L., 1973. Fishes of Arizona. Arizona Game and Fish Department.

Mitsch, W.J., and Gosselink, J.G., 1986. Wetlands. Van Nostrad Reinhold, New York. 539 pp.

Moody, D.W., Chase, E.B., and Aronson, D.A., 1986. National Water Summary 1985--Hydrologic Events and Surface Water Resources. U.S. Dep. Inter., USGS, Water Supply Paper 2300. 506 pp.

Mooney, H.A., 1988. Southern coastal scrub. *In* M.G. Barbour and J. Major (eds.), Terrestrial vegetation of California, California native plant society, Special Publ. No. 9. 1020 pp.

Moore, D., 1989. Opportunities for riparian ecosystem preservation in the Verde River Basin, Arizona, pp. 351-360. *In* Proc of the symposium on headwaters hydrology. American Water Resources Association, Bethesda, Maryland.

Moyle, P.B., 1976. Inland fishes of California. Univ. of California Press, Berkeley. 405 pp.

Omernick, J.M., 1986. Ecoregions of the conterminous United States. Map. U.S. EPA. Corvallis Environmental Research Laboratory

Ono, R., Dana, J.D., Williams, A.W., 1983. Vanishing fishes of North America. Stone Wall Press, Washington, DC. 257 pp.

Ornduff, R., 1974. California plant life. University of California Press, Berkeley. 152 pp.

Pendleton, R.F., Dollar, H.D., Law, Jr., L., McCollum, S.H., and Belz, D.J., 1984. Soil survey of Broward County, Florida, eastern part. USDA, SCS; Univ. of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Station, and Soil Science Department; Florida Department of Agriculture and Consumer Services. 123 pp.

Rea, A.M., 1988. Habitat restoration and avian recolonization from wastewater on the Middle Gila River, Arizona. International Research and Development Conference, Tucson, Arizona, Oct. 1985, Whitehead, E.E., et al. (eds.). pp. 1395-1405

Richardson, M.L., and Miller, M.L., 1974. General soil map with interpretations for land use planning in Pima County, Arizona. USDA, SCS; The Pima County Natural Resource Conservation District. 32 pp.

Riley, L., and Riley, W., 1981. Guide to the National Wildlife Refuges. Anchor Books, Anchor Press/Doubleday, Garden City, New York.

Shipman, G.E., 1981. Soil survey of Santa Barbara County, California, south coastal part. USDA, SCS; University of California Agricultural Experiment Station. 144 pp.

Smith, W.I., 1975. Soil survey of Harrison County, Mississippi. USDA, SCS; Texas Agricultural Experiment Station. 80 pp.

Stephens, F.G., 1982. Soil survey of Tulare County, California, central part. USDA, SCS; USDI, BIA; University of California Agricultural Experiment Station. 165 pp.

Stuck, W.M., 1980. Soil survey of Beaufort and Jasper Counties, South Carolina. USDA, SCS; South Carolina Agricultural Experiment Station; South Carolina Land Resources Conservation Commission. 179 pp.

Synder, J.R., Herndon, A., and Robertson, Jr., W.B., 1990. South Florida Rocklands. *In* R.L. Myers and J.J. Ewel (eds.), Ecosystems of Florida. p. 230-281. University of Central Florida Press, Orlando.

Tiner, Jr., R.W., 1984. Wetlands of the United States: current status and recent trends. U.S. Fish and Wildlife Service, 59 pp. USDA, Soil Conservation Service, 1981. Land resource regions and major land resource areas of the United States. Agriculture Handbook 296.

Trahan, L.J., Bradley, J.J., Morris, L., McDaniel, D.R., and Nolde, R., 1989. Soil survey of St. Bernard Parish, Louisiana. USDA, SCS; Louisiana Agricultural Experiment Station; Louisiana State Soil and Water Conservation Committee. 96 pp.

Tugel, A.J., and Woodruff. G.A., 1986. Soil survey of San Bernardino County, California, Mojave River area. USDA, SCS; University of California Agricultural Experiment Station. 211 pp.

Turner, A.J., 1982. Soil survey of Willacy County, Texas. USDA, SCS; Texas Agricultural Experiment Station. 137 pp.

U.S. Environmental Protection Agency, 1986. Ambient Aquatic Life Water Quality Criteria for Chlorpyrifos. Office of Research and Development, Environmental Research Laboratories, Duluth, Minnesota, and Narragansett, Rhode Island.

U.S. Fish and Wildlife Service, 1984. The salt marsh harvest mouse/California clapper rail recovery plan. U.S. Fish and Wildlife Service, Sacramento, California. 141 pp.

U.S. Fish and Wildlife Service, 1985. Recovery plan for the light-footed clapper rail. U.S. Fish and Wildlife Service, Portland, Oregon. 121 pp.

Valverde, M.A., and Hill, H.L., 1981. Soil survey of Kern County, California, southeastern part. USDA, SCS; University of California Agricultural Experiment Station. 195 pp.

Wachtell, J.K., 1978. Soil survey of Orange County and western part of Riverside County, California. USDA, SCS; University of California Agricultural Experiment Station. 149 pp.

Walker, W.W., 1991. Water quality trends at inflows to Everglades National Park. Water Resourc. Bull. 27(1):59-72.

Welch, L.E., 1977. Soil survey of Contra Costa County, California. USDA, SCS; University of California Agricultural Experiment Station. 122 pp.

Welch, L.E., 1981. Soil survey of Alameda County, California. USDA, SCS; University of California Agricultural Experiment Station. 103 pp.

Wettstein, C.A., Noble, C.V., and Slabaugh, J.D., 1987. Soil survey of Indian River County, Florida. USDA, SCS; Univ. of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Station, & Soil Science Department; Florida Department of Agriculture and Consumer Services. 217 pp.

Wheeler, F.F., 1976. Soil survey of Harris County, Texas. USDA, SCS; Texas Agricultural Experiment Station; Harris County Flood Control District. 140 pp.

Wicker, K.M., Johnston, J.B., and Young, M.W., 1980. Mississippi deltaic plain regional ecological characterization: a habitat mapping study. U.S. Fish and Wildl. Serv., FWS/OBS-79/07.

Wilkes, R.L., Johnson, J.H., Stoner, H.T., and Bacon, D.D., 1974. Soil survey of Bryan and Chatham Counties, Georgia. USDA, SCS; University of Georgia, College of Agriculture, Agricultural Experiment Station. 71 pp.

Williams, D., Thompson, C.M., and Jacobs, J.L., 1977. Soil survey of Cameron County, Texas. USDA, Soil Conservation Service, in cooperation with the Texas Agricultural Experiment Station. 92 pp.

Zeiner, D.C., Laudenslayer, Jr., W.F., and Mayer, K.E. (eds.), 1988. California's wildlife, Vol. 1, amphibians and reptiles. California Dep. of Fish and Game, The Resources Agency. 272 pp.

Zeiner, D.C., Laudenslayer, Jr., W.F., Mayer, K.E., White, M. (eds.), 1990. California's Wildlife, Vol. 2, birds. Calif. Dep. of Fish and Game, The Resources Agency. 731 pp.

Appendix G. Acronyms and Glossary

A

Absorption — The taking up of liquids by solids, or the passage of a substance into the tissues of an organism as the result of several processes (diffusion, filtration, or osmosis); the passage of one substance into or through another (e.g., an operation in which one or more soluble components of a gas mixture are dissolved in a liquid).

Acceptable Daily Intake (ADI) — The maximum dose of a substance that is anticipated to be without lifetime risk to humans when taken daily.

Acetylcholinesterase (AChE) — An enzyme produced at junctions between nerve cells that hydrolyzes acetylcholine, thereby ending transmission of a nerve impulse.

Acidic Soil — Soil having a pH value lower than 7.

Active Ingredient (a.i.) — In any pesticide product, the component which kills, or otherwise controls, target pests; pesticides are regulated primarily on the basis of active ingredient.

Acute Exposure — A single exposure to a toxic substance that results in severe biological harm or death; acute exposures are usually characterized as lasting no longer than 1 day.

Acute Toxicity — The potential of a substance to cause injury or illness when given in a single dose or in multiple doses over a period of 24 hours or less.

Acute Toxicity Study — A study with single (or multiple administration for no more than 24 hours) dose exposure with short-term monitoring for effects (up to 14 days); may include median lethality and effective dose (LD_{50}, LC_{50}, ED_{50}, EC_{50}), eye toxicity, dermal toxicity (excluding skin sensitization tests), and inhalation toxicity studies.

ADI — See Acceptable Daily Intake.

Adsorption — Attraction or bonding of ions or compounds, usually temporarily to the surface of a solid (compare with Absorption).

Aerobic Occurring or growing in the presence of oxygen; life or processes that require, or are not destroyed by, oxygen.

a.i. See Active Ingredient.

Alkaline Soil Soil having a pH value greater than 7.

Ambient Air Open air; an unconfined portion of the atmosphere.

Annual A plant that completes its entire life cycle from seed germination to seed production and death within a single season.

APHIS Animal and Plant Health Inspection Service; an agency within the United States Department of Agriculture.

Application Rate The amount of pesticide product applied per unit area.

Aquatic Life Organisms inhabiting water for all or part of their life cycle.

Aquifer An underground geological formation, or group of formations, containing usable amounts of groundwater that can supply wells and springs; an underground water resource.

Arachnid A member of the class Arachnida, a group of invertebrates characterized by four pairs of jointed appendages; spiders, mites, and scorpions are arachnids.

Assay A test or measurement used to evaluate a characteristic of a chemical; see Bioassay, Mutagenicity Assay.

Atmosphere The mass of air surrounding the earth, composed largely of oxygen and nitrogen; a standard unit of pressure representing the pressure exerted by a 29.92 inch column of mercury at sea level at 45° latitude and equal to 1,000 grams per square centimeter.

Attractant, Insect A natural or synthesized substance that lures insects by stimulating their sense of smell; sex, food, or oviposition attractants are used in traps or bait formulations.

B

Bacteria

A group (division) of microscopic organisms; bacteria consume or break down organic matter and other chemicals, thereby reducing potential for pollution; bacteria in soil, water or air can also cause human, animal, and plant health problems.

Bioaccumulation

Uptake and temporary storage of a chemical in or on an organism; over a period of time a higher concentration of chemical may be found in the organism than in the environment.

Bioassay

A method for quantitatively determining the concentration of a substance or its effect on a living animal, plant, or micro-organism under controlled conditions.

Bioconcentration

The property of some chemicals to collect in tissues of certain species at concentrations higher than the surrounding environment; term is used primarily for aquatic species; see Bioaccumulation.

Biodegradation

The processes by which living systems, particularly micro-organisms, break down chemical compounds; the products of biodegradation may be more or less toxic than their precursors.

Biodiversity

The relative abundance and frequency of biological organisms within ecosystems.

Biological Control

The reduction of pest populations by means of living organisms encouraged by humans; utilizes parasites, predators, or competitors to reduce pest populations (also called biocontrol).

Biotechnological Control

Use of genetic engineering to control a pest; may involve genetic engineering of host plants, biocontrol agents, or the pest itself to achieve control.

Boron

A chemical element that has been suggested for use against Medfly.

Buffer Zone

An area where control treatments are foregone or are modified to protect an adjacent environmentally sensitive area.

By-product

Material, other than the principal product, that is generated as a consequence of an industrial process.

C

Cancellation — Cancellation of a pesticide registration under section 6(b) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); cancellation is required if unreasonable adverse effects to the environment and public health develop when a product is used according to widespread and commonly recognized practice, or if its labeling or other material required to be submitted does not comply with FIFRA provisions.

Carcinogen — A cancer-producing substance.

Certified Applicator — Commercial or private applicator certified as competent to apply pesticides.

CFCs — See Chlorofluorocarbons.

CFR — Code of Federal Regulations (U.S.).

Chlorofluorocarbons (CFCs) — A family of inert, nontoxic, and easily liquified chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants; because these compounds are not destroyed in the lower atmosphere, they drift into the upper atmosphere where their chlorine components destroy ozone.

Chlorpyrifos — An organophosphate insecticide, analyzed for use in this program as a soil drench.

Chronic Toxicity — An adverse biologic response, such as mortality or an effect on growth or reproductive success, resulting from repeated or long-term (equal to or greater than 3 months) doses (exposures) of a compound usually at low concentrations; see Acute Toxicity, Subchronic Toxicity.

Clastogenic — Any adverse effect to an organism, for example from a chemical, that results in structural changes in chromosomes (primarily breaks in chromosomes).

Clay — Soil particle less than 0.0002 mm in diameter; the soil textural class characterized by a predominance of clay particles.

Community — An assemblage of populations of plants, animals bacteria, and fungi that live in an environment and interact with one another, forming a distinctive living system with its own composition, structure, environmental relations, development, and function; an association of interacting populations, usually defined by the nature of their interaction or the place in which they live.

Concentration — The ratio of the mass or volume of a solute to the mass or volume of the solution or solvent; the amount of active ingredient or herbicide equivalent in a quantity of diluent (e.g., expressed as lb/gal, ml/liter, etc.), or an amount of a substance in a specified amount of medium (e.g., air and water).

Conservation — Avoiding waste of, and renewing when possible, human and natural resources; the protection, improvement, and use of natural resources according to principles that will assure their highest economic or social benefits.

Contaminant — An undesired physical, chemical, biological, or radiological substance that can have an adverse affect on air, water, soil, etc.

Conterminous United States — Those states of the United States that are contained within a single continuous border (the lower 48 states).

Control — Action or treatment to reduce a pest population; also, an untreated test group.

Control Treatment — A treatment (application) used within an insect control program; or in an analytical context, the absence of an application, as in the control for a test of an insecticide application.

Cover — Vegetation or other material providing protection as ground cover.

Criteria — Descriptive factors taken into account by EPA in setting standards to various pollutants; these are used to determine limits on allowed concentration levels and to limit the number of violations per year.

Criteria Pollutants — The 1970 amendments to the Clean Air Act required EPA to set National Ambient Air Quality Standards for certain pollutants known to be hazardous to human health; EPA has identified and set standards to protect human health and welfare effects of these pollutants.

Critical Habitat Habitat designated as critical to the survival of an endangered or threatened species, and listed in 50 CFR 17 or 226.

Cultural Control Reduction of insect populations by utilization of agricultural practices such as crop rotation, clean culture, or tillage.

Cytogenetic Pertaining to the formation or production of cells.

D

D-limonene A chemical extracted from citrus peel that has been proposed as a potential control for Medfly.

Decomposition The breakdown of materials by bacteria and fungi; the chemical makeup and physical appearance of materials are changed.

Degradation Breakdown of a compound by physicochemical or biochemical processes into basic components with properties different from those of the original compound; see Biodegradation.

Delayed Neurotoxicity Transformation of a compound by physicochemical degeneration of the axons of peripheral motor nerves that commences 7 to 10 days after exposure to a causative agent such as an organophosphate insecticide.

Deoxyribonucleic Acid (DNA) The molecule in which the genetic information for most living cells is encoded; viruses also contain DNA.

Deposit A quantity of a pesticide deposited on a unit area.

Dermal Exposure The portion of a toxic substance that an organism receives as a result of the substance coming into contact with the organism's body surface.

Dermal Sensitization Dermal exposure to an allergen that results in the development of hypersensitivity.

Developmental Toxicity The adverse effects on a developing organism that may result from its exposure to a substance prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation; adverse

developmental effects may include lethality in the developing organisms, structural abnormalities, altered growth, and functional deficiency.

Diazinon An insecticide registered for use in a variety of agricultural and home applications; diazinon was banned by EPA in 1986 for use on open areas such as sod farms and golf courses.

Diversity The distribution and abundance of different plant and animal communities and species within an area; the number of species in a community or region; see Biodiversity.

DNA See Deoxyribonucleic Acid.

Dose A given quantity of material that is taken into the body; dosage is usually expressed in amount of substance per unit of animal body weight often in milligrams of substance per kilogram (mg/kg) of animal body weight, or other appropriate units; in radiology, the quantity of energy or radiation absorbed; see Concentration.

Drench Saturation of a soil with pesticide, usually to control root diseases.

Drift The airborne movement of a pesticide away from the targeted site of an application.

E

EC_{50} See Median Effective Concentration.

Eclosion The emergence of an adult insect from a pupal case, or the emergence of an insect larva from an egg.

Economic Threshold A pest population level at which economic damage begins to occur; this level may vary depending upon crop and locality.

Ecoregion A geographic area that is relatively homogeneous with respect to ecological systems.

EIS See Environmental Impact Statement.

Endangered Species A plant or animal species identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act, as amended, that is in danger of extinction throughout all or a significant portion of its range.

Environment The sum of all external conditions affecting the life, development, and survival of an organism; all the organic and inorganic features that surround and affect a particular organism or group of organisms.

Environmental Assessment (EA) A concise public document which provides sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement or Finding of No Significant Impact. It aids in compliance with the National Environmental Policy Act (NEPA) when no Environmental Impact Statement is needed.

Environmental Fate The result of natural processes acting upon a substance; including transport (e.g., on suspended sediment), physical transformation (e.g., volatilization, precipitation), chemical transformation (e.g., photolysis), and distribution among various media (e.g., living tissues); the transport, accumulation, and disappearance of a chemical in the environment.

Environmental Impact Statement (EIS) A document prepared by a Federal agency in which anticipated environmental effects of alternative planned courses of action are evaluated; a detailed written statement as required by section 102(2)(C) of the National Environmental Policy Act (NEPA).

EPA U.S. Environmental Protection Agency

Eradication The complete elimination of a pest species; for some agricultural pests, this may mean the reduction of the pest populations to nondetectable levels.

Erosion The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff, but can be intensified by land cleaning practices related to farming residential or industrial development, road building, or timber cutting.

Estimated Environmental Concentration (EEC) Concentration of a substance in a particular media (soil, air, water, or vegetation), estimated from its chemical properties (e.g., volatility, half-life), considering media characteristics.

Estuary	Regions of interaction between rivers and near shore ocean waters where tidal action and river flow.
Exposure	The condition of being subjected to a substance that may have a harmful effect.
Exposure Analysis	The estimation of the amount of chemicals to which organisms are subjected during the application of pesticides.
Exposure Scenario	Overall description of the potential contact of an organism or population under specified conditions (i.e. routes of contact, exposure duration) used to estimate possible exposure during pesticide application.

F

Fenthion	An organophosphate insecticide, analyzed for use in this program as a soil drench.
Feral	Wild; applies to Medfly pest populations rather than Medfly sterile releases.
Fertilizer	Any organic or inorganic substance, either of natural or synthetic origin, which is added to the soil to provide elements essential to or enhancing plant growth.
Fetotoxic	Capable of causing adverse effects to the fetal stage of development.
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act; the Act establishes procedures for the registration, classification, and regulation of pesticides.
Finding of No Significant Impact (FONSI)	A document prepared by a Federal agency that presents the reasons why a proposed action would not have a significant impact on the environment and thus would not require preparation of an Environmental Impact Statement. A FONSI is based on the results of an Environmental Assessment.
FONSI	See Finding of No Significant Impact.
Food Web	An abstract representation of the various food pathways (energy flow) through populations in the community.

Formulation — The way in which a basic pesticide is prepared for practical use; includes preparation as wettable powder, granular, or emulsifiable concentrate; a pesticide preparation supplied by a manufacturer for practical use; a pesticide product ready for application; also, refers to the process of manufacturing or mixing a pesticide product in accordance with the EPA-approved formula.

Full Foliar Coverage — Applied thoroughly over the crop or plant to a point of runoff or drip.

Fumigant — Pesticide applied as liquid or powder which volatilizes to gas; usually applied beneath a tarp, sheet, or other enclosure.

Fumigation — Use of chemicals in gaseous form to destroy pests, usually applied under a cover or shelter.

Fungi (Singular, Fungus) — A group of organisms that lack chlorophyll (i.e., are not photosynthetic) and which are usually multicellular, filamentous, and nonmobile; they include the molds, mildews, yeasts, mushrooms, and puffballs; some decompose organic matter, some cause disease, others stabilize sewage and break down solid wastes in composting.

FWS — Fish and Wildlife Service; an agency of the U.S. Department of the Interior.

G

Gene — A short length of a chromosome that influences a set of characters; a length of DNA that directs the synthesis of a protein.

Genotoxicity — A specific adverse effect on the genome (the complement of genes contained in the haploid set of chromosomes) of living cells, that upon the duplication of the affected cells, can be expressed as a mutagenic or a carcinogenic event because of specific alteration of the molecular structure of the genome.

Geochemical Cycles — Changes in chemical and geological properties of a substance over time.

Gravid — Bearing eggs.

Ground Cover Plants grown to keep soil from eroding.

Groundwater The supply of freshwater found beneath the Earth's surface (usually in aquifers), which is often used for supplying wells and springs. Because groundwater is a major source of drinking water, there is growing concern over areas where leaching agricultural or industrial pollutants or substances from leaking underground storage tanks are contaminating groundwater.

H

Habitat The place occupied by wildlife or plant species; includes the total environment occupied.

Half-life The time necessary for the concentration of a chemical to decrease by 50%; a measure of the persistence of a chemical in a given medium (the greater the half-life, the more persistent a chemical is likely to be).

Hazard The potential that the use of a pesticide would result in an adverse effect on man or the environment; the intrinsic ability of a stressor to cause adverse effects under a particular set of circumstances.

Hazard Assessment A component of risk assessment that consists of the review and evaluation of toxicological data to identify the nature of the hazards associated with a chemical, and to quantify the relationship between dose and response.

Herbicide Chemical designed to kill or inhibit unwanted plants or weeds.

Herbivore An animal that feeds on plants.

Host Any plant or animal attacked by a pest or a parasite.

Human Health Risk Assessment Quantitative appraisal of the actual or potential effects of a pollutant on humans, such as workers or residents.

Hydrolysis The decomposition of chemical compounds through a reaction with water.

I

Immunopathologic Of a disease or abnormality of the immune system.

Immunosuppressive Having the quality or capability to impair the function of the immune system.

In Vitro In glass; a test-tube culture; any laboratory test using living cells taken from an organism.

In Vivo In the living body of a plant or animal; in vivo tests are those laboratory experiments carried out on whole animals or human volunteers.

Inhalation Exposure of test animals through breathing, either to vapor or dust, for a predetermined time.

Inhalation Toxicity The quality of being poisonous to man or animals when breathed into the lungs.

Insect Growth Regulators Substances (often hormones) which exert an effect on insect growth; they may be used to prevent growth or metamorphosis of pests, thereby exerting control over pest populations.

Insecticide A pesticide compound specifically designed to kill or control the growth of insects.

Integrated Pest Management (IPM) The selection, integration, and implementation of pest control actions on the basis of predicted economic, ecological, and sociological consequences; the process of integrating and applying practical methods of prevention and control to keep pest situations from reaching damaging levels while minimizing potentially harmful effects of pest control measures on humans, nontarget species, and the environment.

Irrigation Technique for applying water or waste water to land areas to supply the water and nutrient needs of plants.

K

Kytoon A gas-filled balloon measuring 6 to 8 feet in length and 3 to 4 feet in diameter, used to mark boundaries of spray blocks and sensitive sites. Colors are white and bright orange.

L

Label All printed material attached to or part of the pesticide container.

LC See Lethal Concentration.

LC_1 A concentration of a substance in water or air, expressed in milligrams per liter (mg/L) or milligrams per cubic meter (mg/m^3) that is lethal to 1% of test animals.

LC_{50} Median lethal concentration; the concentration of a toxicant necessary to kill 50% of the organisms in a population being tested; usually expressed in parts per million (ppm), milligrams per liter (mg/L) or milligrams per cubic meter (mg/m^3).

LD See Lethal Dose.

LD_1 The dose of a toxic substance at which 1% of the test organisms die.

LD_{50} Median lethal dose; the dose necessary to kill 50% of the test organisms; usually expressed in milligrams of chemical per kilogram of body weight (mg/kg).

Leaching Downward movement of materials in the soil through water or other aqueous media. Soluble nutrients, such as nitrate, are often leached out of the seedling root zone.

LEL See Lowest Effect Level.

Lethal Concentration (LC) A concentration of a substance in water or air that is lethal to a test organism.

Lethal Dose (LD) A dose of a substance that is lethal to a test organism.

LOAEL See Lowest Observed Adverse Effect Level.

LOEC See Lowest Observed Effect Concentration.

LOEL See Lowest Observed Effect Level.

Lowest Effect Level (LEL) In a series of dose levels tested, the lowest level at which there is an effect on the species tested.

Lowest Observed Adverse Effect Level (LOAEL) The lowest exposure level at which there are statistically significant increases in frequency or severity of specific adverse effects among individuals of the tested population when compared to the control population.

Lowest Observed Effect Concentration (LOEC) The lowest exposure level (concentration) at which there are any observable differences between the test and control populations.

Lowest Observed Effect Level (LOEL) The lowest exposure level at which there are observable differences between the test and control populations.

M

Macroinvertebrates Invertebrate species that are sufficiently large to be handled without the aid of a microscope.

Malathion Bait An insecticide formulation consisting of the active ingredient malathion mixed with a protein hydrolysate bait; may be applied aerially or from the ground.

Male Annihilation A control method that reduces Medfly populations by employing mass trapping to lure and kill male Medflies before they have a chance to mate.

Margin of Safety (MOS) An arbitrary separation between the highest no effect level of a chemical found by animal experimentation and the level of exposure estimated to be safe for humans.

Media — Specific environments (e.g., air, water, soil) that are the subject of regulatory concern and activities.

mg/kg — Milligrams per kilogram; used to designate the amount of toxicant required per kilogram of body weight of test organisms to produce a designated effect; usually the amount necessary to kill 50% of the test animals.

mg/kg/day — Milligrams per kilogram of body weight per day.

Microbial Degradation — The breakdown of a chemical substance into simpler components by bacteria.

Micro-organism — Living organisms, usually so small that individually they only can be seen through a microscope; see Microbes.

Mist — Liquid particles measuring 40 to 500 microns, that are formed by condensation of vapor; by comparison, "fog" particles are smaller that 40 microns.

Mist Blower — A mechanical pesticide application device that can be used to apply ultra low volume (ulv) pesticides; usually truck mounted.

Mitigate — To lessen the effect; to make less harsh or harmful.

Model — A description, analogy, or abstraction used to help visualize or conceptualize something that cannot be directly observed or measured; a system of postulates, data, and inferences presented as a mathematical description of an entity or a state of affairs.

Modeling — An investigative technique using a mathematical or physical representation of a system or theory that accounts for all or some of its known properties; models are often used to test the effect of changes of system components on the overall performance of the system.

Monitoring — The act of measuring environmental conditions through time periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media, humans, animals, or other living things; also the act of measuring operational components or results to verify the efficacy of treatments.

Monotypic — Including a single representative species.

Morphological Pertaining to the shape or structure of an organism or object.

Morphology The branch of biology that deals with the forms and structures of animals and plants.

MOS See Margin of Safety.

Mutagen A substance that tends to increase the frequency or extent of genetic mutations (changes in hereditary material); any substance that can cause a change in genetic material.

Mutagenicity Capacity of a chemical to cause a permanent genetic change in a cell other than that which occurs during normal genetic recombination.

Mutation A change in the genetic material of a cell.

N

Neoplasm An altered, relatively autonomous growth of tissue composed of abnormal cells, the growth of which is more rapid than that of other tissues and is not coordinated with the growth of other tissues.

NEPA The National Environmental Policy Act of 1969 and subsequent amendments.

Neurotoxic Toxic to nerves or nervous tissue.

Neurotoxicity The quality of exerting a destructive or poisonous effect upon nerve tissue.

No Observed Adverse Effect Level (NOAEL) The highest exposure level tested at which there are no statistically significant increases in frequency or severity of specific adverse effects among individuals of the tested population when compared to the control population.

No Observed Effect Level (NOEL) The highest dose level at which there are no observable differences between the test and control populations.

Nontarget Organisms Those organisms (species) that are not the focus of control efforts.

O

Oncogenic Capable of producing or inducing tumors in animals; the tumors may be either malignant (cancerous) or benign (noncancerous).

Oral Toxicity Toxicity of a compound when given or taken by mouth, usually expressed as number of milligrams of chemical per kilogram of body weight of animal.

Organic Matter Material composed of living and/or once-living organisms (plant, animal, and microbial); organic matter increases the buffer capacity, cation exchange capacity, and water retention of the soil and provides a substrate for microbial activity.

Organic Soil Soil usually containing 20% or more organic matter; may also refer to carbonaceous waste contained in plant or animal matter and originating from domestic or industrial sources.

Organism Any living thing.

Organophosphate Insecticide Class of insecticides (also one or two herbicides and fungicides) derived from phosphoric acid esters, e.g., as malathion and diazinon.

Oxidation The addition of oxygen which breaks down organic waste or chemicals such as cyanides, phenols, and organic sulfur compounds in sewage by bacterial and chemical means; the combination of oxygen with other elements; the process in chemistry whereby electrons are removed from a molecule.

Ozone A gaseous allotrope of oxygen, found in the earth's upper atmosphere; ozone provides a protective layer shielding the earth from the harmful health effects of ultraviolet radiations on humans and the environment; lower in the atmosphere, ozone is a chemical oxidant and pollutant emitted by combustion sources; ozone can seriously affect the human respiratory system and is one of the most prevalent and widespread of all the criteria pollutants for which the Clean Air required EPA to set standards.

Ozone Depletion Destruction of the stratospheric ozone layer which shields the earth from ultraviolet radiation harmful to life; caused by certain chlorine- and/or bromine-containing compounds (chlorofluorocarbons or halons) which break down when they reach the stratosphere and catalytically destroy ozone molecules.

P

Parameter — An attribute or characteristic that can be measured (a measuring tool); in statistics, refers to attributes of models or populations; in chemistry, often refers to the attributes of samples (for example, a water sample); may refer to variables in some contexts.

Parasite — An organism which lives in or on another organism from which it derives its nourishment.

Parasitoid — A parasite which lives within its host only during its larval development, eventually killing the host.

Pathogen — A disease-causing organism.

Perennial — A plant that continues growing from year to year; tops may die back in winter, but roots or rhizomes persist (compare with Annual).

Persistence — The quality of an insecticide or a compound to persist as an effective residue; persistence is related to volatility, chemical stability, and biodegredation.

Pest — An insect, rodent, nematode, fungus, weed, or other form of terrestrial or aquatic plant or animal life, or virus, bacterial, or micro-organism that is injurious to health or the environment.

Pesticide — Any substance or mixture of substances designed to kill insects, rodents, fungi, weeds, or other forms of plant or animal life that are considered to be pests; see Herbicide, Insecticide.

Pesticide Tolerance — The amount of pesticide residue allowed by law to remain in or on a harvested crop; by using various safety factors, EPA sets these levels well below the point where the chemicals might be harmful to consumers.

pH — Numerical measure (negative logarithm of the hydrogen ion activity) of the acidity or alkalinity in a soil or solution; a pH reading of 7 is neutral, less than 7 is acidic, and more than 7 is alkaline (basic).

Physical Control — Physical actions (e.g., fruit stripping or host destruction) taken to control a pest.

Photolysis — The decomposition or dissociation of a molecule resulting from light (ultraviolet) absorption; thus, the decomposition of molecules by sunlight; see Photodegradation.

Phytotoxic — Causing injury or death to plants.

Pica Behavior — Pathological behavior characterized by the persistent eating of nonnutritive, generally nonfood, substances.

Plume — A visible or measurable discharge of a contaminant from a given point of origin; as for example, a plume of smoke from a factory or, in the context of the Medfly program, the intentional venting of methyl bromide from a terminated fumigation; the area of measurable and potentially harmful radiation leaking from a damaged reactor; the distance from a toxic release considered dangerous for those exposed to the leaking fumes.

Population — A potentially interbreeding group of organisms of a single species, occupying a particular space; generically, the number of humans or other living creatures in a designated area.

Potentiation — The action of two or more substances from which one or more enhances the toxicity of another. The potentiator generally is not toxic to the same endpoint as the substance being potentiated.

ppm — Parts per million; the number of parts of chemical substance per million parts of the substrate in question.

R

Reasonable Alternatives — Alternatives to the proposal that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant.

Recharge — The process by which water is added to a zone of saturation usually by percolation from the soil surface, e.g., the recharge of an aquifer.

Reference Dose (RfD) — The term preferred by EPA to express acceptable daily intake for humans; an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population, including sensitive subgroups, that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Region A defined geographic area; regions may be defined administratively (e.g., EPA Region III), politically (e.g., Texas), geographically (e.g., the Southwest), biogeographically (e.g., short-grass prairie), physiographically (e.g., Rocky Mountains), or by other means.

Registration Formal EPA approval and listing of a new pesticide before it can be sold or distributed in intrastate or interstate commerce; registrations are in accordance with FIFRA; EPA is responsible for registration (premarket licensing) of pesticides on the basis of data demonstrating that they will not cause unreasonable adverse effects on human health or the environment when used according to approved label directions.

Registration Standards An individual standard established by EPA for the consideration and approval of a pesticide product.

Regulatory Control A combination of control methods including quarantines and certification treatments; regulatory controls may include chemical and/or nonchemical treatment methods; because of the integrity of the regulatory effort associated with Medfly control programs, regulatory control is discussed within this EIS as a unitized component.

Reregistration The reevaluation and reapproval of existing pesticides originally registered prior to current scientific and regulatory standards; EPA reregisters pesticides through its Registration Standards Program.

Reservoir Any natural or artificial holding area used to store, regulate, or control water.

Residue Quantity of pesticide and its metabolites remaining on and in a crop, soil, or water.

Residual Amount of a pollutant remaining in the environment after a natural or technological process has taken place (e.g., the sludge remaining after initial waste water treatment, or particulates remaining in air after the air passes through a scrubbing or other pollutant removal process).

Resistance The ability of a population or system to absorb an impact without significant change from normal fluctuations; for plants and animals, the ability to withstand adverse environmental conditions and/or exposure to toxic chemicals or disease.

Resource A substance or object required by an organism for normal maintenance, growth, and reproduction; if the resource is scarce relative to demand, it is referred to as a limiting resource; nonrenewable resources (such as space) occur in fixed amounts and can be fully utilized; renewable resources (such as food) are produced at a rate that may be partly determined by their utilization.

RfD See Reference Dose.

Risk The probability that a substance will produce harm under specified conditions.

Risk Analysis An analytical process to determine the nature and often the magnitude of risk to organisms, including attendant uncertainty; an analytical process based on scientific considerations, but also requiring judgment when the available information is incomplete.

Risk Assessment The qualitative and quantitative evaluation performed in an effort to define the risk posed to human health and or the environment by the presence or potential presence and or use of specific pollutants.

Risk Characterization Description of the nature and magnitude of risk; risk characterization uses the information gathered in other stages to represent the overall situation; the toxicity and exposure are considered jointly in the estimation or characterization of risk.

Runoff That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface water; it can carry pollutants from the air and land into the receiving waters.

S

Scoping A process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action.

Secondary Poisoning (Also Secondary Toxicity) Intoxication resulting from feeding on the carcass or gastrointestinal tract contents of a primary victim that died from exposure of toxic materials.

Silt — Fine particles of sand or rock that can be picked by the air or water and deposited as sediment; a soil textural class characterized by a predominance of silt particles.

Socioeconomics — Sociological and economic factors considered together.

Solubility — The property of being able to dissolve in another substance; the mass of a dissolved substance that will saturate a fixed volume of a solvent under static conditions.

Species — A group of closely related, morphologically similar individuals which actually or potentially interbreed; a reproductively isolated aggregate of interbreeding populations of organisms.

Spot Treatment — A pesticide application to a small, or otherwise restricted area of a whole unit.

Stratosphere — The upper portion of the atmosphere, in which temperature varies very little with changing altitude and clouds are rare.

Subchronic Toxicity — Adverse biologic response of an organism, such as mortality or an effect on growth or reproductive success, resulting from repeated or short-term (3 month) doses (exposures) of a compound, usually at low concentrations; see Acute Toxicity, Chronic Toxicity.

Suppression — Reduction of a pest population to below some predetermined economic threshhold.

Surrogate Species — A substitute species that can be compared with a lesser known or more rare species.

Susceptibility — Capacity to be adversely affected by pesticide exposure.

Synergism — The action of two or more substances to achieve an effect of which each is individually incapable; synergistic effects may be greater or less than the sum of effects of the substances in question.

Systemic — Entering and then distributing throughout the body of an organism, as in the movement of a toxicant.

T

Target	The plants, animals, structures, areas, or pests to be treated with a pesticide application.
Teratogen	Any substance capable of producing structural abnormalities of prenatal origin, present at birth or manifested shortly thereafter; a substance that causes physical birth defects in the offspring following exposure of the pregnant female.
Teratology	The division of toxicology that deals with development and congenital malformations.
Threatened Species	Any species listed in the Federal Register that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
Threshold Limit Value-Time Weighted Average (TLV-TWA)	The time-weighted average concentration for a normal 8-hour workday and a 40-hour work week to which nearly all workers may be repeatedly exposed without adverse effect.
Tolerance	Amount of pesticide residue permitted by Federal regulation to remain on or in a crop, expressed as parts per million (ppm); capacity to withstand pesticide treatment without adverse effects on normal growth and function; the maximum residue concentration legally allowed for a specific pesticide, its metabolites, or breakdown products, in or on a particular raw agricultural product, processed food, or feed item, expressed as parts per million.
Toxic	Poisonous to living organisms.
Toxicant	A poisonous substance such as the active ingredient in pesticide formulations that can injure or kill plants, animals, or micro-organisms.
Toxicity	The capacity or property of a substance to cause any adverse effects, based on scientifically verifiable data from animal or human exposure tests; that specific quantity of a substance which may be expected, under specific conditions, to do damage to a specific living organism; capacity of a chemical to induce an adverse effect.

Toxicity Categories

EPA definitions: Category I. The words Danger-Poison and the skull and crossbones symbol are required on the labels for all highly toxic compounds. These pesticides all fall within the acute oral LD_{50} range of 2 mg/kg. Category II. The word *Warning* is required on the labels for all moderately toxic compounds. They all fall within the acute oral LD_{50} range of 50 to 500 mg/kg. Category III. The word *Caution* is required on labels for slightly toxic pesticides that fall within the LD_{50} range of 500 to 5,000 mg/kg. Category IV. The word *Caution* is required on labels for compounds having acute LD_{50}s greater than 5,000 mg/kg.

Trophic Level

Functional classification of organisms in a community according to feeding (energy) relationships; the first trophic level includes green plants, the second trophic level includes herbivores, and so on.

U

Ultra Low Volume

Sprays that are applied at 0.5 gallon or less per acre or sprays applied as the undiluted formulation.

Uncertainty

May be due to missing information, or gaps in scientific theory; whenever uncertainty is encountered, a decision, based upon scientific knowledge and policy, must be made; the term "scientific judgment" is used to distinguish this decision from policy decisions made in risk management.

USDA

United States Department of Agriculture.

USDI

United States Department of the Interior.

V

Volatility

The tendency of a substance to evaporate at normal temperatures and pressures.

Volatilization

The vaporizing or evaporating of a substance chemical; phase conversion of a liquid or solid into vapor.

W

Watershed

A terrestrial area that contributes to water flow.

Appendix H. Index